ALIGNING ELECTRICITY ENERGY POLICIES IN ALASKA: ANALYSIS OF THE POWER COST EQUALIZATION AND RENEWABLE ENERGY FUND PROGRAMS

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Abstract

Most rural Alaska communities are not road connected and must cope with challenging arctic environmental conditions. Due to their remoteness and sparse populations, these villages depend on isolated non-grid connected electric generation systems that operate on fuel oil. In Alaska, the Power Cost Equalization program is a 25 year long energy subsidy that targets rural residents to provide energy costs relief. A more recent state incentive program, the Renewable Energy Fund, was developed to expand the use of renewable resources and lower the cost of energy. Some rural communities have benefited from this program and have integrated renewable energy to their systems, particularly installing Wind-Diesel systems. Both programs have congruent goals of alleviating dependence on high cost fossil fuels to generate electricity as means to foster development and higher quality of life in rural Alaska communities. However, their incentive structure may conflict. This paper provides a review of these two energy subsidy policies with a particular focus on the Power Cost Equalization program and offers potential changes to its structure such that social cost impacts to rural residents are minimized while removing incentive barriers against energy efficiency and integration of renewable energy in rural Alaska communities.

A mis padres

Francisco Villalobos Pereda

y

Verónica Meléndez Valles

¡Gracias por darme una educación, los amo!

To my husband

George P. Rankin

Thank you for your love and unconditional support.

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Chapter 1 Power Cost Equalization

Introduction

Rural Alaska communities are remote, subject to challenging environmental conditions and sparsely populated. These factors make it very difficult and costly to provide basic services. In particular, providing energy is a unique challenge in Alaska compared to other locations in the country because of relatively high heating degree days, poor housing stock and soils that pose difficulties for construction of infrastructure. While rural Alaska may represent an extreme example, these issues are not unique to Alaska and there are no simple solutions to "…overcome the problems of high cost, remoteness and lack of economic base. Subsidies seem to be required to bridge the gap between high cost and affordable rates" (Colt, Goldsmith, & Wiita, 2003). Most rural Alaska communities have mixed subsistence-cash economies with limited cash employment available to residents. Over the years the Alaska State Legislature has established a number of programs to help rural residents cope with high energy prices, not only to provide economic relief to households but also with the intent to help support economic development in remote communities.

Two important electricity and energy subsidies established by the Legislature are the Power Cost Equalization (PCE) and the Renewable Energy Fund programs (REF).

The Power Cost Equalization program is intended to bring greater parity between electricity rates in rural Alaska and Alaska's urban centers of Anchorage, Fairbanks and Juneau. This program has existed for almost three decades, but recently as a result of increased fuel and electricity prices since 2008, there is renewed interest in the PCE program.

As a response to historic high fossil fuel prices in 2008, the Alaska State Legislature created the Renewable Energy Fund program, a grant program to encourage the development of renewable centralized energy generation. In 2010 the Legislature set energy policy goals of generating 50% of Alaska's electricity from renewable energy by 2025 and reducing per capita electricity use by 15% by 2020.

The research presented in this monograph investigates how the currently structured PCE program interacts with these recently adopted goals, and by extension the REF program. First, I will discuss the history of the PCE program and how the program operates, respectively followed by a brief discussion on the history and structure of the REF program. Then I will describe the differences in consumption and electricity rates among PCE communities across various regions of Alaska. Subsequently, I will provide an analysis of the PCE program effects on incentives for efficiency and innovation. Finally, I will review alternative formula structures, how these affect the PCE program and resulting policy implications.

Evolution to Power Cost Equalization

After the Prudhoe Bay oil field and Trans-Alaska pipeline began operation in 1977, state revenues grew dramatically. High state revenues as a result of high oil prices facilitated the efforts to advance rural electrification. However, high fuel prices also significantly increased the cost of generating power in rural Alaska. Hence, the Legislature sought not only to expand rural electrification but also to make electricity more affordable. Some legislators at that time were concerned with the ability of utilities to remain solvent since they were facing large increases in fuel prices. Over the next few years, the Alaska State Legislature actively debated energy policy covering a wide span of issues form affordability and power availability in rural areas, to development of hydroelectric generating facilities and progressive goals of developing other renewable energy sources, as well as oil and gas policy. Many decisions during this time regarding the PCE program and other policies were made in the political arena and were a result of trade-offs negotiated as part of the legislative process. Nonetheless, here I focus on the history of policy decisions that gave origin to the PCE program.

The discussion first centered on a scheme called Lifeline Rate. This concept was crafted by the Alaska Public Interest Research Group and introduced in the 1978 legislative session as House Bill (HB) 937 by the House Commerce Committee. Though the bill had no hearings, it provided a concrete proposal to discuss how to establish an energy assistance program. The Lifeline Rate would provide a structure where grants would be made available to utilities to subsidize the equivalent of 200 (later 300 and 600) kilowatt-hours (kWh) per month per residential customer so that every consumer had the ability to consume at least a minimum amount of power; also the intention was to “shift some of the utilities’ cost to larger users” (State of Alaska Division of Strategic Planning, 1985).

Concerns highlighted during this debate were that the subsidy be fixed, or have a ceiling in place, so that it would not fluctuate with fuel prices in order to avoid a situation in which the energy subsidy be “raised year after year” (State of Alaska Division of Strategic Planning, 1985). There were also concerns that the Lifeline Rate did not promote energy conservation as it would effectively provide ‘free’ energy to rural customers since the subsidized power provided would be 200 kWh per month when average consumption was thought to be about 150 kWh per month (State of Alaska Division of Strategic Planning, 1985). Later during the 1980 legislative session, the limit of the subsidized power was raised to 600 kWh through an amendment. However, the bill included a provision in which the program was set to end in five years which would allow time for the Alaska Power Authority to “have found rural diesel alternatives” (State of Alaska Division of Strategic Planning, 1985).

This program was supported by legislators from the rural areas or ‘bush caucus’. However, legislators from Anchorage voiced concerns about how ‘reasonable’ the subsidy was and insisted that the subsidy structure not be directly tied to fuel prices, and that a ceiling be in place to ensure consumers paid their “fair share” (State of Alaska Division of Strategic Planning, 1985). The Governor’s[1] office also voiced concerns regarding issues of energy conservation and management challenges. In their view, if the subsidy was provided for delivered cost of power at the consumer level the program would become an “administrative nightmare” (State of Alaska Division of Strategic Planning, 1985).

Shortly after, between 1979 and 1980, another option surfaced for discussion and was called Power Production Cost Assistance (PPCA). This concept was crafted by Arthur Young and Company for the Dillingham Representative Nels Anderson (Matz & Kreinheder, 1988). These two alternatives, the Lifeline Rate and PPCA, were debated as ways to improve affordability of power in rural Alaska and help rural electric utilities to remain operational as there were concerns that “if electric rates got too high, consumers would simply cease to pay” (State of Alaska Division of Strategic Planning, 1985). The

[1] The Governor was Jay Sterner Hammond, who advocated for environmentally and fiscally responsible government.

PPCA program would financially support the utilities by paying a subsidy to cover a portion of their power production costs based on a sliding scale. One of its goals was to promote equipment efficiency without causing consumer demand to increase.

Representative Anderson introduced HB 758 which became part of the omnibus bill HCS SB 438. This was a major energy bill containing many important energy-related components including the bulk fuel program, business tax credit for energy conservation, and several hydroelectric amendments; it passed in 1980. This action was seen by critics of the PPCA program as a political move to ensure its passage, as HB 438 included the appropriation of funds for the Susitna hydroelectric project. Governor Hammond voiced his objections and nearly vetoed HCS SB 438 am H because of the power cost assistance provision (State of Alaska Division of Strategic Planning, 1985).

He wrote to the Legislature,

> The current design of this electric power subsidy program has a number of defects. The distribution of benefits is inequitable, inefficiencies are encouraged, incentives to conserve energy and search for alternatives are diminished, program administration is cumbersome, and total cost is uncertain. I gave serious thought to vetoing the bill in order to prevent the creation of a program, which I believe establishes a dangerous precedent. However, because of the many worthwhile and crucially needed elements of the bill, I feel I must accept the power production subsidy as well. However, I intend to submit legislation which will modify the subsidy design in order to reduce the problems noted above. (Hammond as cited in Matz & Kreinheder, 1988).

Despite the Governor's dissent, he signed the bill and the Power Production Cost Assistance program was established. The purpose of the program was to have the State pay a portion of generation and transmission cost for utilities with high rates which would be used by the utilities to reduce residential rates and rates for community facilities and charitable organizations. About 15 utilities participated in this program benefiting 11,405 residential and commercial customers, 238 organizations and 473 community facilities (Alaska PowerAuthority, 1988). The PPCA program subsidized about 33% (40,490 megawatt-hours) of the generated power. At that time the average cost of fuel per gallon for participating utilities was $1.054 or about $2.64 in 2010 dollars (2010$).[2] However, the program only lasted one fiscal year during which it distributed $2,183,168 in assistance, about $5.5 million (2010$). The efforts by the Governor to re-structure the program were defeated by legislation and "created a legislative opportunity to expand the program and make it permanent" (State of Alaska Division of Strategic Planning, 1985). Governor Hammond's proposed changes included a subsidy of 100% of the price of power between $0.15 per kWh and $0.40 per kWh for no more than 200 kWh for eligible consumers, and the program was to be terminated once the Permanent Fund Dividend Program was established; or by decreasing funding at a rate of 20% per year until the program was eliminated.

Instead, in October 1980, the legislature established the Power Cost Assistance (PCA) program. The program was expanded from Hammond's proposed changes and increased the subsidy limit to a range between 12.6 and 42.75 cents per kWh. For community facilities, it subsidized 55 kWh per month multiplied by the community population while also including charitable educational facilities. Finally, it removed the sunset provision and increased the minimum subsidized cost by one cent per year.

Most of these changes were again driven by political maneuvering. Through continued changes and expansion this program morphed into the program that exists to this day, Power Cost Equalization. In 1985, shortly after it was established, the origins of the program were described as follows in an Anchorage Daily News article:

> Power Cost Equalization is the result of a legislative trade by urban politicians who wanted Bush support for massive hydroelectric projects –the proposed Susitna and Bradley Lake Projects in the Railbelt and four other dams in Southeast Alaska. In return for tens of millions of dollars in state money invested

[2] PCE program data is calculated on a fiscal year basis. The fiscal year starts in July and ends in June. Estimation of figures in constant dollars is done using the average CPI for a fiscal year.

> in waterpower engineering and construction the Bush delegation won equalization. (Mauer, 1985).

Equalization was established although it remained controversial and many considered the arrangement as an unfair wealth distribution plan where "rural Alaska permanent subsidies would be part of the problem – not a solution" (State of Alaska Division of Strategic Planning, 1985). Even so, to this day the PCE program continues to provide economic relief to rural communities throughout the state, but it does not address the problems of high costs and low cash incomes.

Power Cost Equalization Established

The Power Cost Equalization program was created in 1984 when the state Legislature enacted the Alaska Statutes 44.83.162-165 replacing the Power Cost Assistance program. The program became effective in October 20, 1984 (FY 1985) and was funded through appropriations from the general fund of about $6.67 million (2010$). The challenges of providing affordable and reliable power in rural Alaska have been ever present and they have compelled policy makers to take action. However, the decisions on how to structure assistance programs has been politically driven and to this day continue to impact the ability of rural Alaska communities to harness alternatives to electricity generated by diesel fuel. The history of the program is perceived to be one of expansion and cost containment battles due to continuous need for increased funding. However, the history of PCE is more complex.

The PCE program was the result of the debate of how to provide assistance to rural utilities in the late 70s which started with the simple concept of the Lifeline Rate to provide temporary cost relief and a survival level of power for rural consumers. Though this concept started the debate on how to structure a subsidy program, it was never implemented. Instead, the Power Production Cost Assistance program and later the Power Cost Assistance program were established. With the transition from PCA to PCE there was an important shift in purpose. With the previous programs the goal was to provide some level of temporary relief for rural customers that were paying high prices; distinctly PCE has the purpose of "*equalizing* power costs per kilowatt-hour statewide at a cost close or equal to the mean of the cost per kilowatt-hour in Anchorage, Fairbanks and Juneau by paying money from the fund to eligible electric utilities in the state" (State of Alaska, 1989). This is an important shift because as PCE is currently structured, as fuel prices increase and the price gap increases between rural and urban communities, rural communities need to receive larger subsidies in order to equalize electricity rates. This is because in the Railbelt area, Anchorage power is primarily provided by lower cost natural gas which has historically been a stable fuel source; Fairbanks though dependent on fossil fuels such as coal and diesel enjoy a less volatile local supply, as well as the benefits of the intertie with Anchorage; and southeast hub communities source much of their electricity with subsidized and stable hydroelectric resources enjoying relatively more affordable electricity prices. Equalization also makes the program indefinite because it implies that the program is to remain in place until rates between rural and urban areas are comparable. And thus, equalization is an economically unattainable goal, because urban and rural markets are inherently different, and so are the factors that affect their prices.

Power Cost Equalization Program Implementation

Almost a decade before PCE was established; the Alaska Legislature created the Alaska Power Authority (now Alaska Energy Authority) under House Bill 779 and signed into law by Governor Hammond on July 2, 1976. The purpose of the agency was to "*promote, develop and advance the general prosperity and economic welfare of the people of Alaska by providing a means of constructing, acquiring, financing and operating…power projects…"* (State of Alaska, 1989).

The responsibility of administering the PCE program, and its predecessors, was given to the Alaska Power Authority and the Alaska Public Utilities Commission (APUC, now the Regulatory Commission of Alaska). The responsibilities were divided such that the APUC would evaluate the utility eligibility and subsidy amount per kilowatt-hour, and APA would determine the eligible kilowatt-hours to be subsidized in order to calculate the appropriate payment and make the disbursement. These responsibilities remain to this day.

Because the program was crafted under a political background, the legislature established a criterion for utilities to be eligible to participate in the program, so that the urban areas and the regions that benefited from hydroelectric development (Four Dam

Pool utilities, Kodiak, Port Lions, Valdez, Petersburg, Wrangell and Ketchikan) were excluded (Matz & Kreinheder, 1988). At its inception the program had the following key provisions:

- ✓ Utility provides electric service to the public for compensation
- ✓ During calendar year 1983 less than 7,500 megawatt-hours were sold to residential customers or less than 15,000 megawatt-hours if two communities were served and
- ✓ During calendar year 1984, diesel-fired generators were used to produce 75% of its electricity

The program was also designed and directed toward centralized utilities using diesel fuel to produce electricity. It was also designed to ease the ability of utilities to participate since according to statute "a utility may not be denied power cost equalization because complete cost information is not available" (State of Alaska, 1989). The Legislature also required that participating utilities submit a monthly report that "records monthly kilowatt-hour sales or generation, monthly fuel balances, fuel purchases and monthly utility fuel consumption" (State of Alaska, 1989). AEA would then review these monthly reports, check the calculations, determine the appropriate payment and make the disbursement. Over time changes to PCE have been mostly in two categories, increased levels of funding and changes to eligibility constraints as means of cost containment. Table 1 shows the differences across the programs, which in their basic structure and funding formulas are quite similar.

Table 1: Differences of implemented power cost assistance programs

	PPCA (FY 1981)	PCA (FY 1982-1985)	PCE (FY 1985)	PCE (FY2000)	PCE (FY 2011)
Entry rate (2010 cents/kWh)	18.4	24.3	17.2	15.2	14.0
Ceiling rate (2010 cents/kWh)	96.0	91.2	106.4	66.5	100.0
Eligible costs for reimbursement	85%	95%			
Eligible costs for reimbursement over ceiling	Yes, 100%	No			
Consumption Limits – Community Facilities kWh/month	None	55 kWh per Resident	70 kWh per Resident		
Residential & Commercial Consumption Limits kWh/month	N/A	600	750[c]	500 Commercial no longer eligible	
Eligible cost categories for reimbursement	generation and transmission	generation, transmission, distribution and administrative			

Note: Community facilities is defined as water and sewer facilities, charitable educational facilities, public lighting, or community buildings whose operations are not paid by the state, federal government or private commercial party. Starting in 1993, the PCE eligible kWh per month limit dropped to 700.
Source: Modified table "Comparison of PPCA, PCA, PCE and PCE-REC" (Brooks, 1995).

Because PCE was not the first subsidy structure to be introduced, the sharp growth of the program happened mostly during the PPCA and PCA with another significant increase during the first year of PCE. As Figure 1 shows, there was a rapid increase in appropriations and disbursements from 1981, when PPCA was implemented, to about 1986, one year after the transition to the PCE program criteria[3]. It was in 1986 that the peak level of appropriations for the program occurred, about $43.2 million (2010$). This increase during the early years was due to higher number of participating utilities. Only 15 utilities participated in the PCCA program but that number more than doubled in

[3] Historical data was gathered from PCE Annual Statistical Reports published by the Alaska Energy Authority since 1988.

1982 when it change to the PCA program and it continued growing until about 1988; by then almost 100 utilities were participating in the PCE program. Currently, only 84 utilities are participating in the PCE program representing 185 communities. However, some cooperative utilities have increased the number of communities they represent. For example, in 1985 the Alaska Village Electric Cooperative (AVEC) represented about 46 communities receiving PCE, and it represented about 52 communities in 2010; also the Alaska Power and Telephone Company (AP&T) represented only 4 communities in 1985, but in 2010 it represented 21 communities. Overall, the number of people served has increased about 33% over time. In 1985, about 59,000 people were assisted through the PCE program. About 78,431 people were assisted during fiscal year 2010. There has been a historic tension between high oil prices that benefit the state treasury and the impacts of high prices on Alaskan households. When oil prices are high, state coffers overflow, but these high prices simultaneously put strains on household budgets. As a result of higher costs and lower median incomes, high energy prices are especially hard on rural residents (Saylor, Hayley, & Szymoniak, 2008). When oil prices fall, state budgets are strained in their capacity to pay for any programs, including those directed at relieving rural household energy costs, which remain high as a result of high fixed costs.

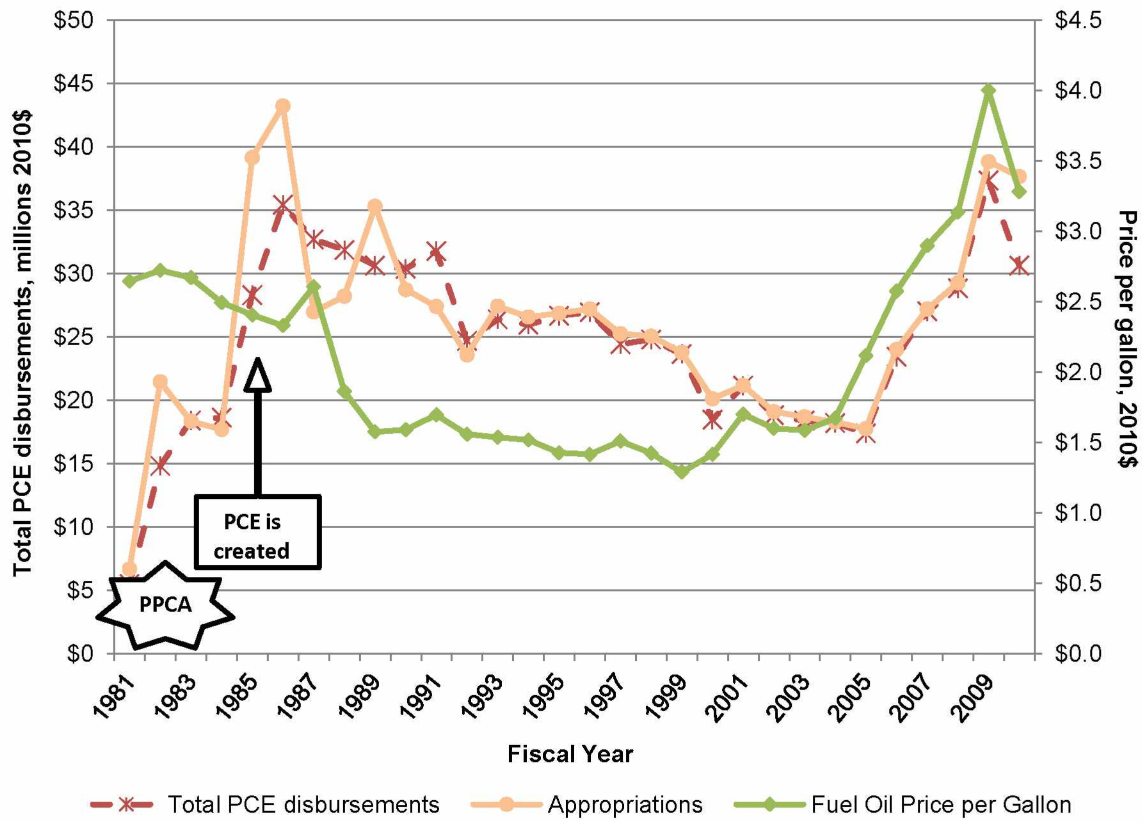

Figure 1: PCE Appropriations, Disbursements and Distillate Fuel Oil Prices per Gallon in the Electric Sector over Time. Source: PCE Statistical Reports 1988-2010 and author's calculations.

Seven years after the PCE program was established, funding the program became a challenge as world oil prices sharply decreased lowering state revenues. Since inception, the program was not fully funded by the Legislature in 15 out of 25 fiscal years. In 1990, in an attempt to contain costs, the Legislature directed the Alaska Public Utilities Commission to implement new efficiency and line loss standards and to more clearly define eligible costs. To further address high operating costs, AEA provided technical support, preventative maintenance and upgrading/replacing equipment of rural utilities (Pourchot, 1990).

In FY 1992, the program was pro-rated to 80% eligible PCE payments because of funding shortfalls for eleven months of the year. One year later, the Power Cost Equalization and Rural Electric Capitalization Fund (the PCE fund) was created by the Legislature with an appropriation of $101 million (2010$). During subsequent years, PCE expenses were drawn exclusively from the PCE fund and were nearly spent by the end of FY 1999 (State of Alaska, Office of the Governor, 1999). This continued to be an issue until FY 2000 when the PCE program had full funding for one year.[4] Then, during FY 2001, the PCE Endowment fund was created. Originally the fund was capitalized using the proceeds from the sale of the Four Dam Pool Projects and funds from the Constitutional Budget Reserve. Later in 2007, the fund was once again capitalized with general funds. The Rural Electric Capitalization Fund and PCE program costs are appropriated using dividends from the PCE fund[5] (Alaska Energy Authority, 2009). For the last three fiscal years, the PCE program again received full funding. Last year the legislature appropriated an additional $400 million for the PCE endowment fund.

Coping with volatile and generally increasing crude and fuel oil prices has been a challenge for the PCE program since its inception. Average fuel oil prices in the power sector in Alaska increased sharply between FY 1980 and FY 1981, and then decreased sharply until FY 1986. For participating utilities, average fuel oil prices were highly volatile but the average annual real price of fuel was relatively stable between FY 1981 and FY 1986. Because PCE was not fully funded in most years from FY 1992 through FY 2007, fuel prices and program payments were not highly correlated. Figure 1 also shows how after the first year the PCE program was created, the total amount of funds disbursed steadily decreased while fuel oil prices had a volatile but relatively flat trend. However, after FY 2005 high fuel prices and program growth resulted in record high PCE disbursements. In FY 2009, coinciding with the 2008 crude oil price run up, PCE disbursements increased to about $37 million (2010$).

Total electricity (kWh) sales of participating utilities steadily increased until FY 1999, the last year commercial customers where eligible to receive the PCE credit (Figure 2). Some of this increase resulted from additional utilities participating in the program. In FY 1999, in addition to eliminating reimbursements to commercial customers, the number of eligible kWh per month per residential customer was also decreased from 700 to 500 kWh. After that adjustment, consumption re-adjusted and continued an upward trend. However, the total number of kilowatt-hours eligible for reimbursement has remained

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[4] Appendix A details PCE funding levels per year

[5] The fund is managed by the Department of Revenue; it is invested to earn 7% over time. Seven percent of the fund's 3-year monthly average returns may be appropriated.

relatively flat over time following adjustments in eligibility levels in FY 1993[6] and FY 2000. During the years of the PCE predecessor programs both sales and eligible kilowatt-hours exhibited higher growth, largely due to the increase in the number of participating utilities. In CY 2010 there were 190 eligible communities who participated in the PCE program (Table 2).

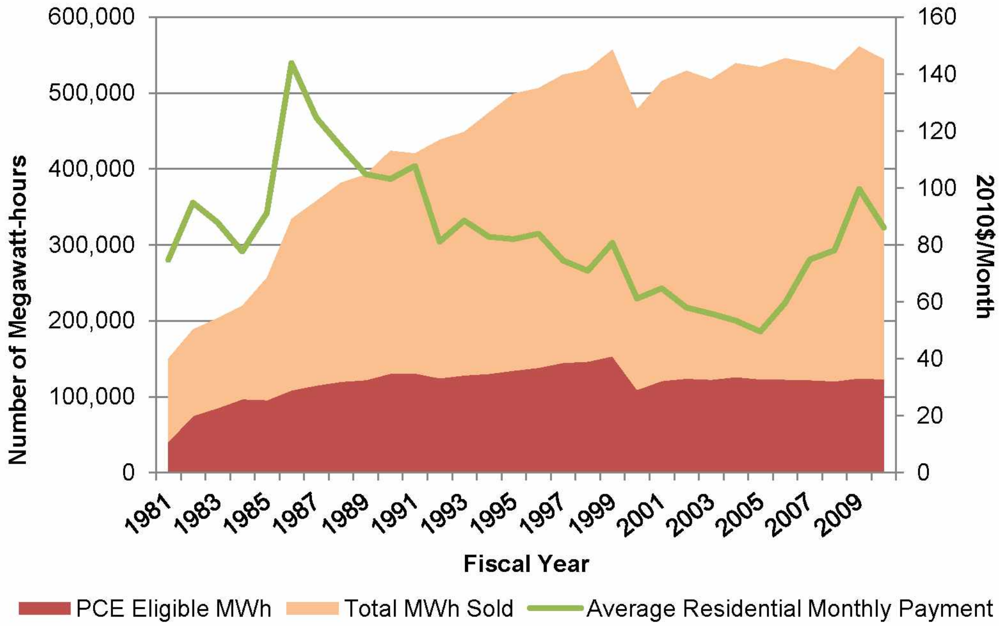

Figure 2: Power Sold, PCE Eligible kWh and Average Residential Monthly Payment, 1981 to 2010.
Source: PCE Annual Statistical Reports 1988-2010 and author's calculations.

6 In 1993, residential customer eligible kWh dropped from 750 to 700.

Table 2: Utilities/communities eligible and participating in PCE program, CY 2010

AEA Energy Region	Yes	Inactive	No	Total	Percent Active
Aleutians	12	1	0	13	92%
Bering Straits	17	0	0	17	100%
Bristol Bay	25	1	0	26	96%
Copper River/Chugach	6	0	2	8	75%
Kodiak	4	1	1	6	67%
Lower Yukon-Kuskokwim	48	0	0	48	100%
North Slope	7	1	0	8	88%
Northwest Arctic	12	1	0	13	92%
Railbelt	0	0	14	14	0%
Southeast	21	0	10	31	68%
Yukon-Koyukuk/Upper Tanana	38	3	2	43	88%
Total	**190**	**8**	**29**	**227**	**84%**

Note: For utilities that serve multiple communities with no grid such as AVEC and AP&T, each community is counted individually. Source: Alaska Energy Statistics Report 1960-2010 (Fay, Villalobos Meléndez, & Converse, 2011)

The average number of eligible kilowatt-hours grew at about 5% per year since FY 1985; the average annual population growth in participating utility communities was 2% over the same time period. Figure 2 shows kilowatt-hours sold, PCE eligible kWh and the average residential monthly payment per customer since disbursements became available to residential customers. The sharp declining trend during the 1990s and first half of 2000s results from pro-rated PCE disbursements due to lack of funding (Appendix A). Figure 3 shows kWh sold and PCE eligible kWh with average kWh sold per capita; notably per capita electricity consumption continued to steadily rise in the years of pro-rated funding. The sharp increase starting in FY 1985 coincides with the increase in eligible kWh from 600 (under the PCA program) to 750 after the PCE program was instituted and the increase in participating utilities. The sharp decrease in per capita consumption between FY 1987 and FY 1988 coincides with the crash of the Alaska economy due to a drastic decrease in world oil prices.[7]

[7] Though oil prices decrease, the effects of the economic crash on lowering economic activity and income were likely the cause of the decrease in consumption.

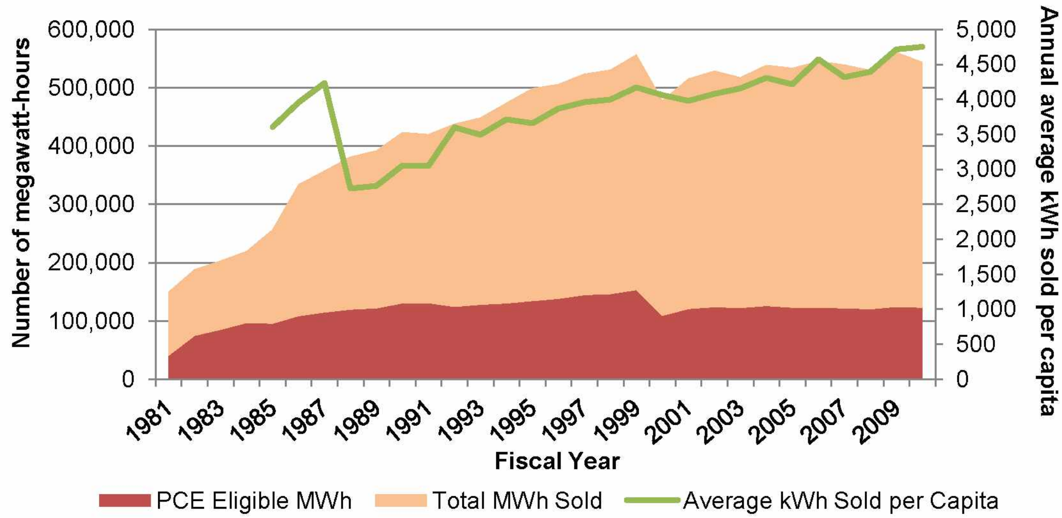

Figure 3: Power Sold, PCE Eligible kWh and Average Annual kWh Sold per Capita, 1981 to 2010. Source: PCE Annual Statistical Reports 1988-2010 and author's calculations.

PCE Level Funding Formula

The PCE program reduces the kWh electric rates charged to rural residents in areas where residential rates are high. The RCA determines utility eligibility and the PCE level (the amount paid per kWh). The PCE level is determined by a formula based on a utility's costs or rates, whichever is less (Figure 4).

Lesser of

PCE Level = [(Non Fuel Costs/kWh Sold + Fuel Costs/kWh Sold) – Base Rate] * 95%

or

PCE Rate = [Residential Rate –Base Rate] * 95%,

if < maximum allowed rate

Figure 4: PCE Level Funding Formula. Source: Power Cost Equalization Program Guide (Alaska Energy Authority, 2009).

A utility's PCE payment per kWh is determined by a formula that covers 95% of a utility's cost between a floor or base rate (average rate for Anchorage, Fairbanks and Juneau, 13.42 cents/kWh) and a ceiling (currently $1.00) for a defined level of consumption (500 kWh for residential customers, and 70 kWh per month multiplied by the community's population for public facilities). The PCE level is re-calculated for eligible utilities once a year by RCA. State and Federal customers as well as commercial customers are not eligible for the PCE credit.

There are other factors that also affect the calculation of the PCE level including minimum efficiency standards for diesel generation depending on the quantity of electricity the utility produces. Table 3 shows how utilities that produce more than 80% of electricity from diesel have slightly higher efficiency standards than those who produce less than 80% of electricity from diesel. Also, utilities that produce more kilowatt-hours are expected to have higher levels of efficiency. In addition, a maximum 12% distribution line loss standard is expected from all utilities. If the minimum level of efficiency or the line loss exceeds the standards allowed, the PCE level is decreased. An important consideration related to these standards is that they have not been updated to keep up with technological change since they were implemented in FY 1990.

Table 3: PCE Minimum Efficiency Standards for Electricity Generation

Total Generation (kWh)			Total Diesel Generation	
			More than 80%	Less than 80%
			kWh/gal	kWh/gal
0	to	99,999	9.5	8.5
100000	to	499,999	10.5	10.0
500000	to	999,999	11.5	11.0
1000000	to	9,999,999	12.5	12.0
	More than	10,000,000	13.5	13.0

Source: Table recreated from the PCE Program Guide (Alaska Energy Authority, 2009).

Participating utilities are required to file reports with both RCA and AEA; these reports are used to approve costs and determine the utility's PCE reimbursement rate per kWh. Unregulated utilities must file an annual report with RCA accompanied by accounting documentation such as balance sheets, invoices and other details to support their costs. RCA uses these records to verify allowable costs for power production. If RCA deems any of the costs ineligible, those costs are not included in the calculation of the PCE level. Regulated utilities can also request a Cost of Power Adjustment (COPA) to adjust their fuel costs between PCE level adjustments. Most utilities participating in the PCE program are unregulated (about 73%).

In addition to annual reports, all participating utilities must file a monthly report with AEA containing production and sales information including total kWh generated, gallons of fuel used, and kilowatt-hours sold. This report is used to determine the number of kilowatt-hours eligible for PCE level reimbursement. Utilities also submit copies of their customer ledger documents that AEA uses to verify that kilowatt-hours sold are eligible. Utilities self report to RCA and AEA; the agencies and their functions relative to the PCE program are independent. Utilities are instructed to submit consistent information to both agencies, but there is no on-going process to audit or reconcile the consistency of the information provided to both agencies.

Chapter 2 Renewable Energy Fund

Early Alaska Renewable Energy Efforts

Unlike the PCE program, the Renewable Energy Fund (REF) does not have a long history. However, there is a long history of public policy concerns related to dependence on volatile and sometimes high priced fossil fuel energy. During times of high oil prices and thus, high and energy costs for residents, state focused on developing alternatives to diesel fired generators in rural Alaska, and large-scale renewable energy sources for urban areas. The REF program does not have direct predecessors as the PCE does (PPCA, PCA). But rather, it is one more tool in a portfolio of actions and programs established by the Legislature to advance renewable energy development. It is not my intention to provide a comprehensive history of Alaska's energy policy, but rather to provide historic highlights regarding renewable energy and conservation at the time that PCE was established and then fast forward to current events regarding the creation of the Renewable Energy Fund Program.

A few years before the PCE program was established, legislators debated the development of a number of hydroelectric projects. Part of the debate revolved around the desirable way to fund these projects; one using state oil revenues through the Permanent Fund or through market mechanisms such as revenue bonds through the Alaska Power Authority.[8] Much of the attention focused on moving the Susitna hydroelectric project forward. During the same 1979 session, House Bill 364 and House Bill 309 were unsuccessfully introduced. They were intended to address issues of conservation; alternative technologies; and thermal, lightning and energy audits. Before the 1980 Legislative session, a large number of energy reports were completed. At least eight of them directly addressed alternative energy resources and conservation.[9] During 1980, the focus was on the omnibus energy bill of HCS SB 438 which "contained most of the energy legislation on the table" (State of Alaska Division of Strategic Planning, 1985). The bill authorized, among other energy legislation, $70 million for Tyee Lake and $120 million each for Swan Lake and Terror Lake hydroelectric projects

[8] The creation of the Alaska Power Authority (APA) was around the same time this debate was happening (1976). So the debate was also about creating APA and how much power would the authority should have.

[9] As listed in The Energy Program for Alaska; Origins and Evolution, 1985.

as well as nine other projects. The bill "mostly…expressed the House Democratic Majority's concern for alternative technology and energy conservation" (State of Alaska Division of Strategic Planning, 1985). The political pressure to build the Susitna Dam continued to mount as job creation became a key component. Though advancing conservation and developing alternative energy were genuine concerns, the underlying driver was building the Susitna hydroelectric project. For the next several years, the politics centered on securing votes to pass hydroelectric projects in the southeast region and Susitna, but mostly debating financing mechanism and securing funding for the projects. Legislators from the southeast region felt compelled to support Susitna to avoid repaying loans and to secure their own hydroelectric projects since in their view "it was obvious that diesel costs would exceed stabilized hydro cost at some time in the future…" (Bob Martin-THREA[10], as cited in State of Alaska Division of Strategic Planning, 1985).

Renewable Energy Fund History

The Renewable Energy Fund was established by the Alaska State Legislature, House Bill 152, in April, 2008 under AS 42.45.045. The new program was received with great enthusiasm by the utilities and Alaska rural communities. The fund is perceived as a grant program to promote renewable energy projects but the legislature's intentions were broader. Some of the main goals of the program are motivated by the following (HB 152, 2008):

- need to lower cost of energy, in fact the legislature stated:"Residents of rural Alaska pay far more for electricity than residents who live on the Railbelt energy grid"
- to develop Alaska renewable energy resources
- to maintain the state's competitiveness
- to promote industry and jobs

The intention of the State Legislature was to appropriate capital funds of $50 million per year for 5 years (HB0152F, 2008). Notwithstanding, in June 2010 Governor Sean Parnell vetoed the appropriations approved by the Legislature and cut them in half to $25 million (Renewable Energy Alaska Project, 2011). To date, the legislature has appropriated $150 million which have funded more than 100 projects. Over the course of

[10] THREA – Tlingit-Haida Regional Electric Authority

four rounds, AEA has received more than 460 applications requesting almost $ 1.1 billion in funding (Fay, Villalobos Melédez, & Crimp, 2012, unpublished data).

The program is administrated by the Alaska Energy Authority. In addition, the program receives input from the Renewable Energy Fund Advisory Committee. The functions of the committee are to support the development of eligibility and evaluation criteria for projects requesting grants. In the early months of 2011, Governor Sean Parnell reappointed Chris Rose, the Executive Director of the Renewable Energy Alaska Project, Brad Reeve, the General Manager and Chief Executive Officer of Kotzebue Electric Association and James Posey, the General Manager at Anchorage Municipal Light & Power to the committee (Renewable Energy Alaska Project, 2011).

The Renewable Energy Fund is not the only program the State has created to try to tackle the issues of high energy costs. Recently, during the 26th legislative session, two major bills were passed: Senate Bill 220, the Alaska Sustainable Energy Act and House Bill 306, An Act declaring a state energy policy. The senate bill seeks to improve energy efficiency in public buildings, established the Emerging Energy Technology Fund, added a tax credit for renewable energy production, developed methodology to collect and store energy consumption and expense data among other actions. As well, HB 306 records the legislative intent of the state of Alaska to increase energy efficiency per capita by 15% by 2020, to increase its electric generation to 50% from renewable sources by 2025 and to declare the state energy policy stating the following:

> …the state's economic prosperity is dependent on available, reliable and affordable residential, commercial and industrial energy to supply the state's electric, heating and transportation needs…It is the policy of the state to (1) institute a comprehensive and coordinated approach to supporting energy efficiency and conservation… [and] (2) encourage economic development by…promoting the development of renewable alternative resources…(HB306 FIN am S, 2010)

The capital budget for fiscal year 2012 appropriated over $303 million for various renewable energy projects (including REF projects) and energy conservation programs including the Alaska Housing Finance Corporation Weatherization Program and Home Energy Rebate Program, the Alternative Energy Conservation Revolving Loan Fund, and the Emerging Energy Technology Fund.

Renewable Energy Fund Grant Process

This grant program follows a strict process that intends to allocate the funds in a fair manner to those communities with the highest need and that have greater probability of succeeding. The process goes as follows:

1. Application is submitted to AEA
2. Economic analysis is performed by contractual economists
3. Economic analysis reviewed/modified by third party quality assurance team
4. Resource technical analysis by AEA's Program Managers
5. AEA recommends projects and respective funding to the legislature
6. Legislature decides whether to fund the project and appropriates funds
7. AEA responsible for disbursement and management of grants

Once a final scoring of the project is made, all projects are ranked by region. As illustrated by Table 4, each application is evaluated using a point-weighted system that analyzes the project viability in a holistic way and places greatest weight in cost of energy, but also taking into account the sustainability of the project.

Table 4: Criterion for Project Evaluation

Evaluation Factor	Weight
Cost of energy	25%
Matching funds	20%
Economic and technical feasibility	20%
Economic and Other Alaska benefits	15%
Project readiness	10%
Sustainability	5%
Local Support	5%

Source: REF Evaluation Guidelines (Alaska Energy Authority, 2011).

The grant administrative cycle has completed four rounds and it finalizing the fifth round. As Table 5 shows, the number of applications has been relatively stable over the four rounds averaging about 112 applications per year. Most of the applications requesting funds, about 26%, have been for wind projects, closely followed by hydroelectric at about 25% and biomass standing as a distant third at about 15% (Figure 5).

Table 5: Summary of RE Fund grants and funding as of January 21, 2012

Category	Round I	Round II	Round III	Round IV	Round V	Total
Applications Received	112	118	123	108	97	558
Projects Funded	79	30	25	74	TBD	208
Grants in Place	72	29	19	50	0	170
Grants Cancelled	5	1	2	0	0	8
Amount Requested ($M)	$453.8	$293.4	$223.5	$123.1	$132.9	$1,226.7
AEA Recommended ($M)	$100.0	$36.8	$65.8	$36.6	$43.1	$282.3
Appropriated ($M)	$100.0	$25.0	$25	26.6	TBD	$176.6
Cash Disbursed ($M)	$54.4	$16.7	$6	$2.6	$0	$79.7
Available for reallocation ($M)	$0	$0	$0.2	$0	$0	$0.2

Source: Reproduced table from Alaska REF Status Report (Alaska Energy Authority, 2012).

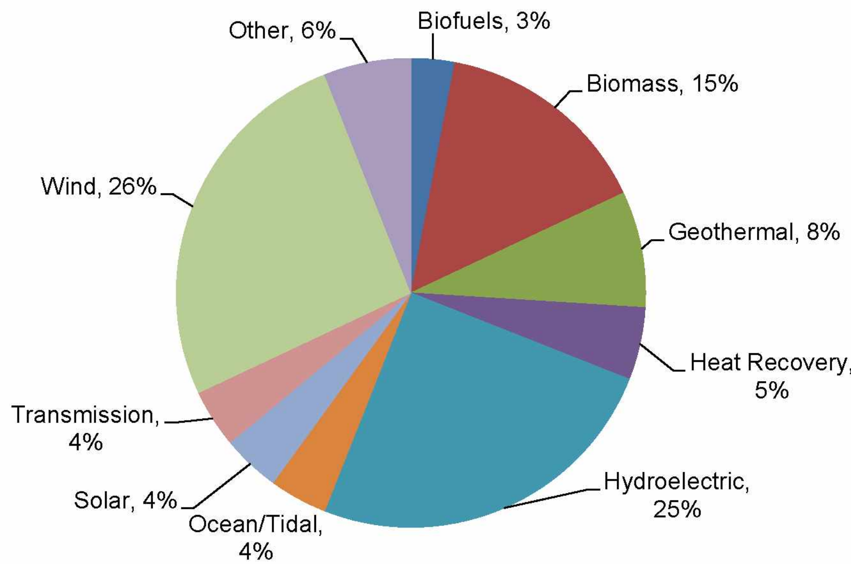

Figure 5: Applications by energy type. Source: Alaska Renewable Energy Fund Grant Program: How it Works and Lessons We've Learned (Fay, Villalobos Melédez, & Crimp, 2012, unpublished data).

Wind energy has been the larger beneficiary of the REF grants receiving about 33% of all of funds appropriated as Figure 6 shows.

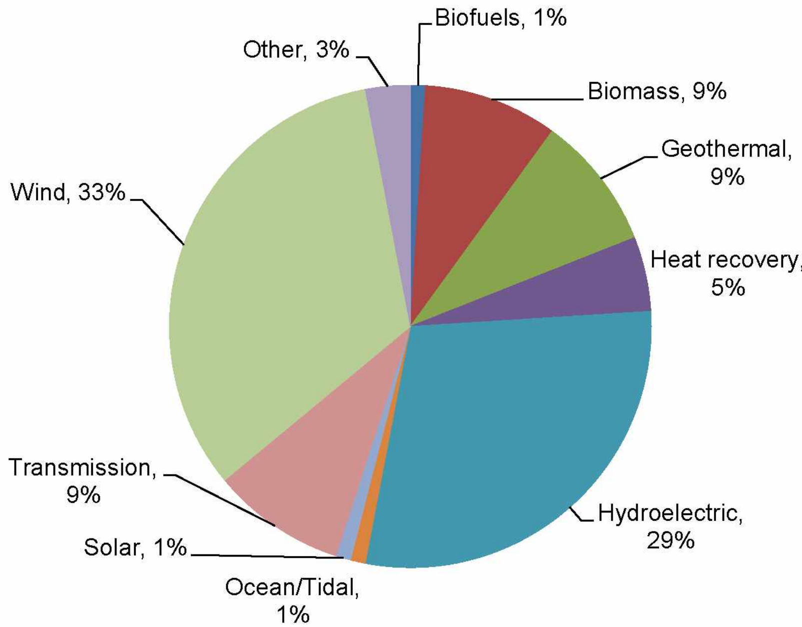

Figure 6: Distribution of Total Funds Appropriated by Project Type. Source: Alaska Renewable Energy Fund Grant Program: How it Works and Lessons We've Learned (Fay, Villalobos Melédez, & Crimp, 2012, unpublished data).

However, the amount of funds requested has decreased in each round, and by Round V it has decreased about 71%. Thought the number of applications requesting funds for hydroelectric and wind projects has been comparable, a higher proportion of wind projects were recommended for funding as Figure 6 shows. It is clear that wind development has expanded by the REF program in a significant way. In fact, most wind turbines installed in Alaska were installed since 2008 when the program was established though not all newer wind projects have received REF funding.

Though on average funds appropriated were close to the $50 million per year intended, the first round of applications benefited from approximately two years worth of appropriations (approximately $100 million) while subsequent rounds were only a quarter of the first round appropriations. Reflective of the changes in the levels of appropriations, the number of projects funded also decreased with each round with only 25 projects funded in the third round. Only about 45% of the total funds appropriated have actually been disbursed. This is a reflection of the caution and efforts of strong level of accountability approach AEA has taken to distributing funds by first writing detailed grant agreements and only providing funds through an invoice reimbursement process. However, this also translates into a slow and bureaucratic process that does not result in rapid alternative energy deployment.

Over the course of four rounds the Southeast region has had the larger number of projects funded, about 21% of total, followed by the Railbelt (18%) and the Lower Yukon-Kuskokwim region a distant third (10%). Overall rural communities account for just over half (52%) of the funded projects (Figure 7).

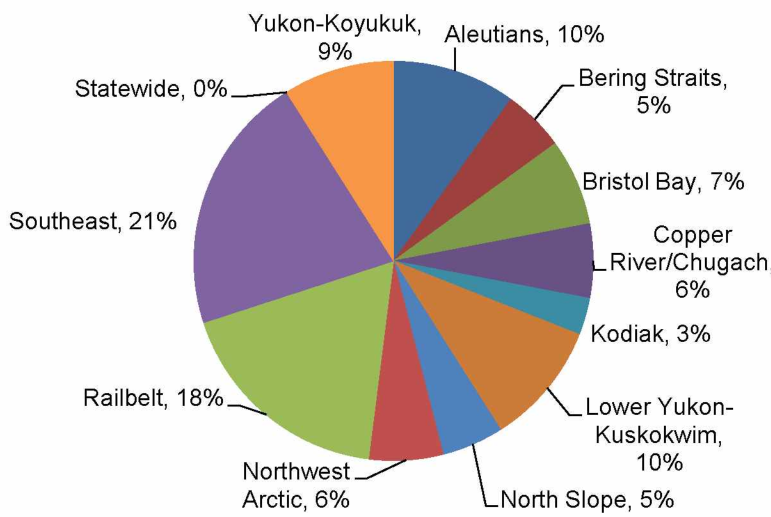

Figure 7: Number of Projects Funded by Region. Source: Alaska Renewable Energy Fund Grant Program: How it Works and Lessons We've Learned (Fay, Villalobos Melédez, & Crimp, 2012, unpublished data).

Following a somewhat similar pattern, as Figure 8 shows, the Southeast region has received the largest share, about 19%, of funding, followed by the Railbelt receiving about 16% and the Lower Yukon-Kuskokwim region a close third receiving about 15% of the funding. Overall, rural communities have received about 51% of the funding.

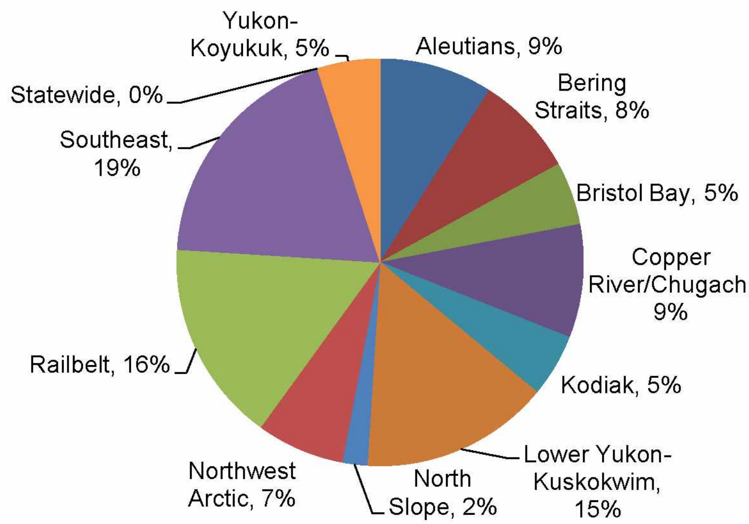

Figure 8: Distribution of Funds Appropriated by Region. Source: Alaska Renewable Energy Fund Grant Program: How it Works and Lessons We've Learned (Fay, Villalobos Melédez, & Crimp, 2012, unpublished data).

Chapter 3 Review of Electricity Consumption and Rates in Alaska Regions and PCE Communities

In Alaska there are large regional differences in consumption and prices that result from proximity to different types and quantities of resources. Differences in remoteness and population size also influence costs. Urban areas in the southern Railbelt benefit from larger economies of scale and access to natural gas and hydroelectric resources; the majority of hydroelectric facilities are located in Southcentral and Southeast Alaska. Most communities in rural Alaska depend on fossil fuels for the generation of electricity and have to cope with the volatility of diesel fuel prices. These differences result in significant differences in energy consumption and prices. The Alaska Energy Authority (AEA) uses eleven energy regions to help identify large geographic areas with similar characteristics. These AEA energy regions are used in this review (Figure 9).

In CY 2009, U.S. residential customers consumed an average of 10,896 kWh per year or 908 kWh per month; the average residential rate was 9.8 cents/kWh. There is no region in Alaska with that level of electricity consumption. Even the region with the highest annual residential consumption (North Slope) consumes almost 25% less (8,230 kWh). The state with the lowest average residential consumption in 2009 was Maine (6,252 kWh). Only two Alaska regions have higher average consumption levels, North Slope (8,230 kWh) and Railbelt (7,514).

Average annual per customer residential consumption in most Alaska regions is between 4,000 and 6,000 kWh per year or 333 and 500 kWh per month. The Yukon-Koyukuk/Upper Tanana region has the lowest at just over 3,000 kWh per year or 250 kWh per month. Within geographic regions there is also considerable variation. For example, in the Railbelt average annual consumption in Fairbanks is 8,285 kWh and Anchorage is 7,475 kWh. Table 6 lists the average annual residential consumption per customer for years 2008 to 2010.

Table 6: Average Residential Consumption by AEA Energy Region

AEA Region	kWh per Customer 2008	2009	2010
Aleutians	4,776	4,788	5,014
Bering Straits	4,569	4,751	4,524
Bristol Bay	4,219	3,910	4,131
Copper River/Chugach	4,054	4,297	4,331
Kodiak	4,380	4,779	5,145
Lower Yukon-Kuskokwim	4,157	4,262	4,333
North Slope	5,918	7,480	8,230
Northwest Arctic	5,537	5,755	5,860
Railbelt	8,080	7,897	7,514
Southeast	6,130	6,256	6,007
Yukon-Koyukuk/Upper Tanana	3,191	3,348	3,322

Source: *Alaska Energy Statistics Report 1960-2010* (Fay, Villalobos Meléndez, & Converse, Alaska Energy Statistics 1960-2010, Preliminary Data, 2011).

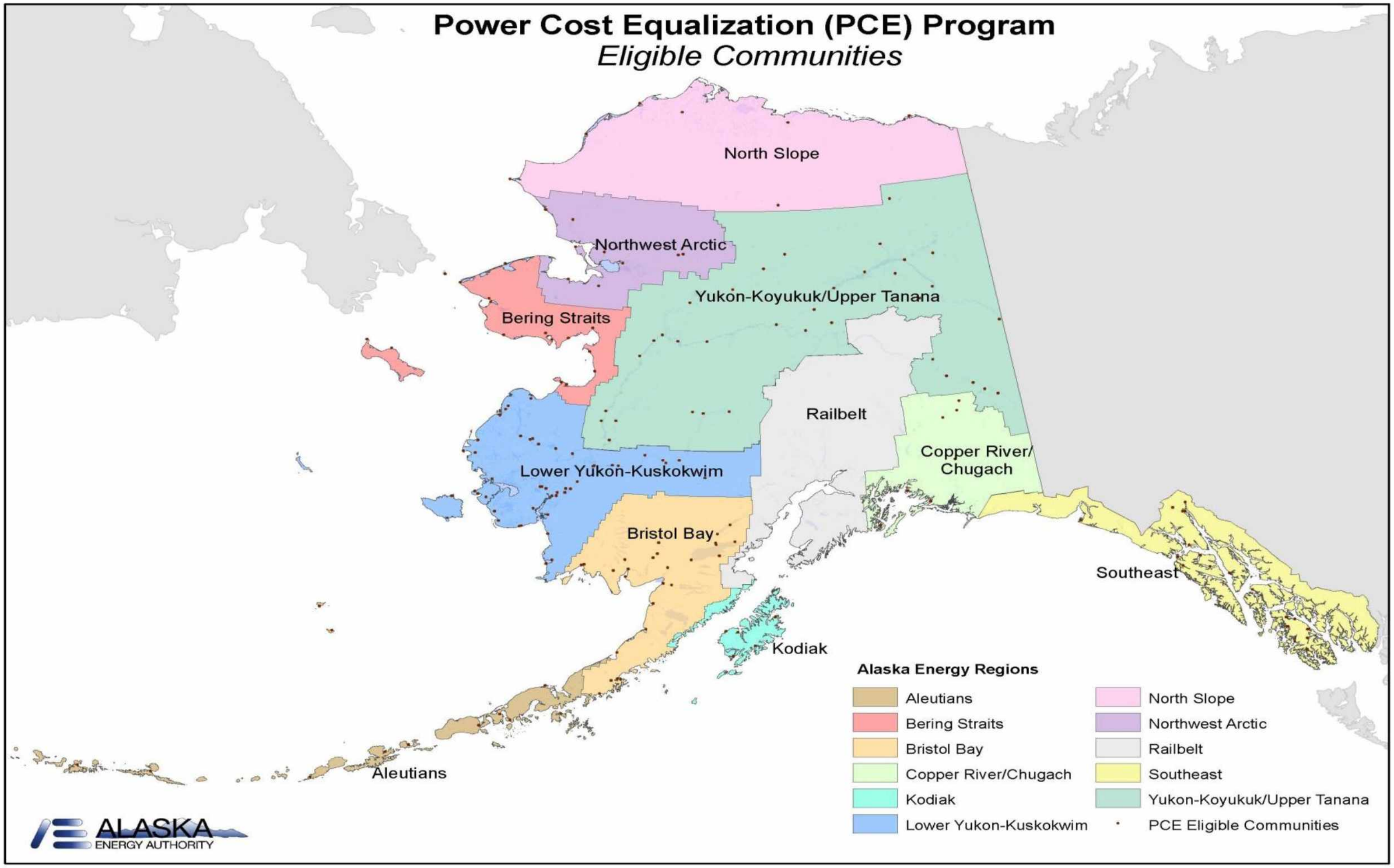

Figure 9: Alaska Energy Regions Map and PCE Eligible Communities. Source: Alaska Energy Authority.

The Alaska statewide weighted average residential rate for electricity (16 cents per kWh in CY2009) is significantly higher in than the U.S. average of 9.8 cents per kWh. Hidden in the statewide average is considerable variation with some communities paying less than the national average and some paying over ten times as much (even when considering Power Cost Equalization program effective rate). Similar to consumption, differences between and within regions are very large. Table 7 shows that the Railbelt and Southeast regions have the lowest average residential rates. North Slope residential customers also have lower average rates because some communities in the North Slope region have access to relatively more affordable natural gas and also additional subsidy payments from North Slope Borough. Most other regions have rates over three times as much as urban Alaska areas. Some communities with hydroelectric power have the lowest rates but in most cases customers are not paying the full, true cost of power because the cost of infrastructure was heavily subsidized by state and federal governments.

Table 7: Average Residential Electricity Rates by AEA Region

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Region	Before PCE			After PCE		
	2008	2009	2010	2008	2009	2010
Aleutians	0.48	0.40	0.44	0.22	0.21	0.21
Bering Straits	0.41	0.47	0.44	0.16	0.20	0.21
Bristol Bay	0.43	0.50	0.47	0.17	0.21	0.28
Copper River/Chugach	0.28	0.25	0.26	0.18	0.19	0.18
Kodiak	0.20	0.17	0.18	0.12	0.13	0.16
Lower Yukon-Kuskokwim	0.52	0.58	0.52	0.19	0.22	0.24
North Slope	0.14	0.14	0.13	0.11	0.13	0.12
Northwest Arctic	0.48	0.56	0.51	0.21	0.20	0.21
Railbelt	0.16	0.16	0.15	0.16	0.16	0.15
Southeast	0.14	0.10	0.12	0.09	0.10	0.10
Yukon-Koyukuk/Upper Tanana	0.53	0.52	0.52	0.20	0.22	0.23

Source: Alaska Energy Statistics Report 1960-2010 (Fay, Villalobos Meléndez, & Converse, 2011).

A review of specific characteristics of resources, consumption and rates in all AEA regions follows below. The figures provided in these summaries are based on CY 2010 data from the *Alaska Energy Statistics Report 1960-2010* accompanying Excel files[11].

Aleutians

The Aleutians Region includes eleven communities. Most communities in this region generate electricity with fuel oil; only about 5% of power generation in the region is from hydroelectric resources. Average annual consumption per customer for communities in this region is between 5,000-6,000 kWh. Communities such as Adak, Nikolski, Nelson Lagoon and False Pass have some of the lowest consumption (about 3,500 kWh) in the region while communities such as Dutch Harbor, Cold Bay, Saint Paul and King Cove have the highest consumption, almost twice as much as communities with the lowest levels. These communities benefit from larger economies of scale not only because they have significantly more residential customers but because they also have more large commercial customers. Without PCE, the communities in this region would pay almost four times more for electricity than the urban customers in the Railbelt. However, with PCE, average rates in the Aleutians region range from about 14-36 cents per kWh.

Bering Straits

The Bering Straits region includes sixteen communities. Most communities in this region generate electricity with fuel oil; only about 5% of power generation in the region is from wind resources. Average consumption per customer for communities in this region is between 4,000-6,000 kWh per year. Communities such as Diomede, White Mountain, Teller and Nome have the lowest levels of consumption ranging from about 3,000-3,500 kWh per year. Koyuk, Saint Michael and Shaktoolik have the highest levels of consumption (almost 6,000kwh). Residential rates range from 36 cents/kWh (Nome) to 72 cents/kWh (White Mountain) before PCE. However, average rates after PCE adjustment range from 14 to 44 cents/kWh with most communities (13 of 16) paying between 33%-66% more than urban customers in the Railbelt.

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[11] *Alaska Energy Statistics Report 1960-2010*
http://www.iser.uaa.alaska.edu/Publications/AlaskaEnergyStatisticsCY2010Tables.xlsx

Bristol Bay

The Bristol Bay region includes twenty two communities. Almost all electricity in Bristol Bay is generated using fuel oil. Communities in the Bristol Bay region have an average consumption per customer ranging between about 3,000 to less than 6,000 kWh per year. Communities such as Levelock, Pilot Point, Egegik and Koliganek have the lowest levels of consumption just over 3,000 kWh per year. Chignik Lagoon, New Stuyahok and Dillingham have the highest levels of consumption of over 5,000 kWh per year. Residential rates before PCE range between 43 to 92 cents/kWh (about three to six times higher than urban customers). Average rates after PCE adjustment range from about 15 to 50 cents/kWh. The highest rates after PCE adjustment are paid by Perryville and Pedro Bay customers, which pay over three times more than urban customers.

Copper River/Chugach

The Copper River/Chugach region includes seven communities. Over half (55%) of all electric generation in this region is done using hydroelectric resources while the rest (45%) is generated using fuel oil. Communities in the Copper River/Chugach region have an average consumption per customer ranging from about 3,300 to 6,200 kWh per year. Valdez and Cordova have the highest consumption and benefit from hydroelectric power generation. Chitina and Slana have the lowest consumption levels. Residential rates before PCE range from 22 to 66 cents/kWh. After PCE, average rates range from 16 to 41 cents/kWh; Tatitlek pays the highest rate.

Kodiak

The Kodiak region includes five communities. Most of the electricity generation in Kodiak is done using renewable resources, about 84 from hydro and about 9% from wind; only 8% of electricity is done using fuel oil. Communities in the Kodiak region have an average consumption per customer ranging from almost 4,000 to over 7,000 kWh per year. Kodiak and Karluk have the highest levels of consumption. Kodiak has large hydroelectric resources and largest wind generation installed capacity in Alaska, producing almost all of its power with renewable resources. Old Harbor and Ouzinkie have the lowest consumption levels. Residential rates before PCE range from 18 to 60 cents/kWh. After PCE, average rates range from 18 to 26 cents kWh; Karluk and Larsen Bay pay the highest rates.

Lower Yukon-Kuskokwim

The Lower Yukon-Kuskokwim region includes 45 communities. Most of the electricity generation in this region is done using fuel oil (98%), although recently a small amount, about 2%, is from wind resources. The Lower Yukon-Kuskokwim region includes a large number of communities (44) and has a wide range of average consumption per customer from about 1,000 to just over 6,000 kWh per year. Lime Village, Stony River and Newtok have the lowest levels of consumption (less 2,000 kWh) while Bethel and Napaskiak have the highest levels of consumption (over 6,000 kWh). Average residential rates before PCE range from 42 cents/kWh to $1.17 per kWh. After PCE, residential rates range from about 13 to 75 cents per kWh. Lime Village pays the highest rate, and Newtok a distant second pays about 39 cents/kWh. About seven communities[12] in this region have wind turbines producing a portion of their electricity.

North Slope

The North Slope region includes eight communities. A unique characteristic of this region as compared to other rural Alaska regions is that almost two thirds of their electricity generation is done using natural gas and only 34% is produced from fuel oil. Natural gas is used in electric generation in the communities of Barrow and Nuiqsut. Also, unlike other regions in rural Alaska, residential customers in the North Slope regions consume electricity at the same levels as urban customers. Average consumption in this region ranges from about 7,500 kWh to almost 10,000 kWh. Anaktuvuk Pass and Kaktovik have the lowest levels of consumption while Atqasuk and Point Hope have the highest. Residential rates before PCE range from 12 to 17 cents. Some communities receive small PCE adjustments and in some cases consumers may enjoy even lower rates than urban consumers because the electricity rates are also subsidized by the borough.

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[12] The seven communities are: Chevak, Hooper Bay, Kasigluk, Mekoryuk, Quinhagak, Toksook Bay and Kongiganak; for details on wind generation in 2010 please see *Alaska Energy Statistics Report 1960-2010* http://www.iser.uaa.alaska.edu/Publications/AlaskaEnergyStatisticsCY2010Tables.xlsx

Northwest Arctic

The Northwest Arctic region includes ten communities. Most electricity generation in this region is done using fuel oil (91%), followed by a small amount of renewable resources, about 7% from hydroelectric and 2% from wind. The Northwest Arctic region consumes electricity closer to the levels of urban consumers. Average residential consumption per customer ranges from almost 5,000 kWh to almost 8,000 kWh. Ambler, Kobuk and Kiana have the lowest levels of consumption while Shungnak, Noatak and Kotzebue have the highest levels. Residential rates before PCE are high, ranging from 47 to 87 cents per kWh. However, after PCE rates range from 17 to 30 cents per kWh; Buckland and Kobuk have the highest rates.

Railbelt

The Railbelt includes five urban communities: Anchorage, Palmer-Wasilla, Fairbanks, Homer and Seward and are not eligible for the PCE adjustment. There are six interconnected utilities that serve this region.[13] These utilities not only serve the main urban centers but also a number of communities along the Railbelt that are connected to the grid (Appendix C). Most of the electricity generated in the Railbelt is from natural gas (72%), followed by fuel oil (11%), hydroelectric (10%) and coal (8%).[14] Average residential consumption per customer ranges from over 7,000 to almost 8,500 kWh per year. Homer has the lowest consumption levels while Palmer (Mat-Su area) has the highest consumption levels. Average residential rates range from 13 cents/kWh in Anchorage to 20 cents/kWh in Fairbanks.

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[13] These utilities are: Chugach Electric Association (CEA), Anchorage Municipal Light & Power (AML&P), Golden Valley Electric Association (GVEA), Homer Electric Association (HEA), Matanuska Electric Association (MEA), and Seward Electric Association (SEA). In addition, Copper Valley Electric Association (CVEA) serves two small communities in the Railbelt region Lake Louise and Nelchina. CEA is the main utility provider for the Cooper River/Chugach area as defined by the AEA Energy Regions.

[14] Generation by fuel type figures are estimates for CY 2010 from the *Alaska Energy Statistics Report 1960-2010* (Fay, Villalobos Meléndez, & Converse, Alaska Energy Statistics 1960-2010, Preliminary Data, 2011) available at http://www.iser.uaa.alaska.edu/Publications/AlaskaEnergyStatisticsCY2010Report.pdf

Southeast

The Southeast region includes twenty-six communities and consumption varies significantly across communities. Some communities have abundant hydroelectric resources while other communities may be significantly smaller and only have diesel generation systems. In total about 97% of all electric generation in Southeast is produced with hydro while only 3% is produced with fuel oil. Average residential consumption per customer ranges from almost 2,000 to just over 15,000 kWh per year. A portion of the consumption in communities with the highest consumption is due to the use electric heating. Communities with the highest levels of consumption (above 10,000 kWh/year) include Ketchikan, Metlakatla, Wrangell, Sitka and Petersburg; none of these communities are eligible to receive PCE. However, most other communities (20) in the region are eligible and receive PCE; this is because they generate electricity mostly with fuel oil and have rates up to two or three times as much as the subsidized hydro communities with lower rates. For example, even after the PCE adjustment communities such as Angoon, Hoonah, Whale Pass among others pay about 20 cents/kWh and Tenakee Springs paid the highest average rate of about 30 cents/kWh. The average residential rate for these high consumption communities is between 9 and 11 cents per kWh; again these lower rates are the result of subsidized infrastructure and do not reflect the true cost of power from these facilities. Communities with the lowest levels of consumption (below 2,000 kWh/year) include Gustavus, Elfin Cove and Tenakee Springs, which also have a relatively high portion of seasonal second homes. Average residential rates for the rest of the region range between 21 and 64 cents per kWh, before PCE. After PCE, average residential rates range from 15 to 32 cents per kWh; Tenakee Springs and Gustavus have the highest rates.

Yukon-Koyukuk/Upper Tanana

The Yukon-Koyukuk/Upper Tanana region includes thirty communities. Average residential consumption per customer ranges from about 1,500 to almost 5,500 kWh per year. Tok and Huslia have the highest consumption levels in the region, while Chakyitsik and Manley Host Springs have the lowest levels of consumption. Before PCE, residential rates range from 39 cents/kWh to $1.02 per kWh. After PCE, residential rates range from 14 to 54 cents per kWh. Chalkyitsik and Takotna pay the highest rates.

PCE Communities Rates and Consumption

The biggest challenge in providing electricity (and other public services) to rural residents lies in the lack of economies of scale; this intractable problem is difficult to overcome. The fixed costs associated with running a utility are large and if the number of customers and/or levels of consumption are very small these costs must be spread out over very few customers and kilowatt-hours. Most PCE communities are similar in that they produce all or most of their electricity using diesel generators, have small populations, and customers pay electricity rates higher than customers in Anchorage, Fairbanks and Juneau. However, across PCE communities there are significant differences in remoteness, population sizes (ranging from 8 to about 6,000 people), available means for transporting and storing fuel, income and other factors that ultimately affect their electricity prices.[15] Hence, there is a large variability in electricity rates across PCE communities, which in turn, affect their levels of electricity consumption.

However, on average, PCE residential customers consume significantly less (over 40%) electricity per month than customers in urban areas of Alaska. The average PCE utility generates less than 3,000 MWh per year; about 30% of the utilities generate less than 500 MWh and the smallest generate less than 30,000 kWh per year. By comparison, urban utilities (Anchorage and Fairbanks) generate over 1 million MWh per year. This means urban utilities produce over 300 times as much power as the average PCE utility. Overall, less than 30% of all kWh sold in PCE communities receive PCE credit. However, the importance of this assistance to residential customers and community facilities is significant. As illustrated in Figure 10, in CY2010, almost 70% of all residential kilowatt-hours received PCE credit. PCE also provides significant assistance to community facilities; Figure 11 shows that of all kilowatt-hours consumed by community facilities in CY2010, about 50% received PCE reimbursement.

[15] Appendix C lists PCE communities and their residential and effective rates, average consumption per residential customer per month, population, average household size (2004), average real median income (2004) and average fuel prices in 2009.

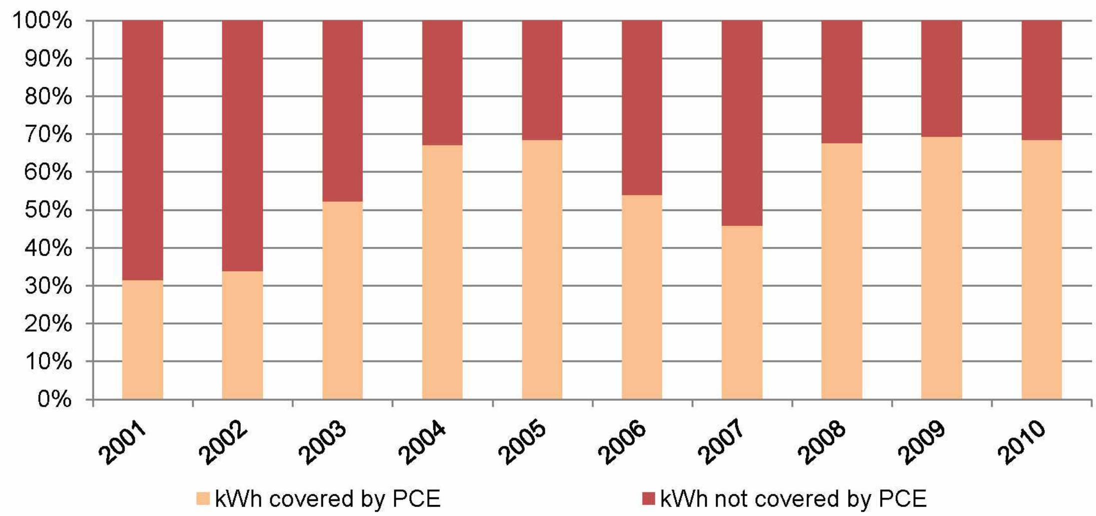

Figure 10: Residential kWh Sold in PCE communities. Source: PCE Annual Statistical Reports 1988-2010 and author's calculations.

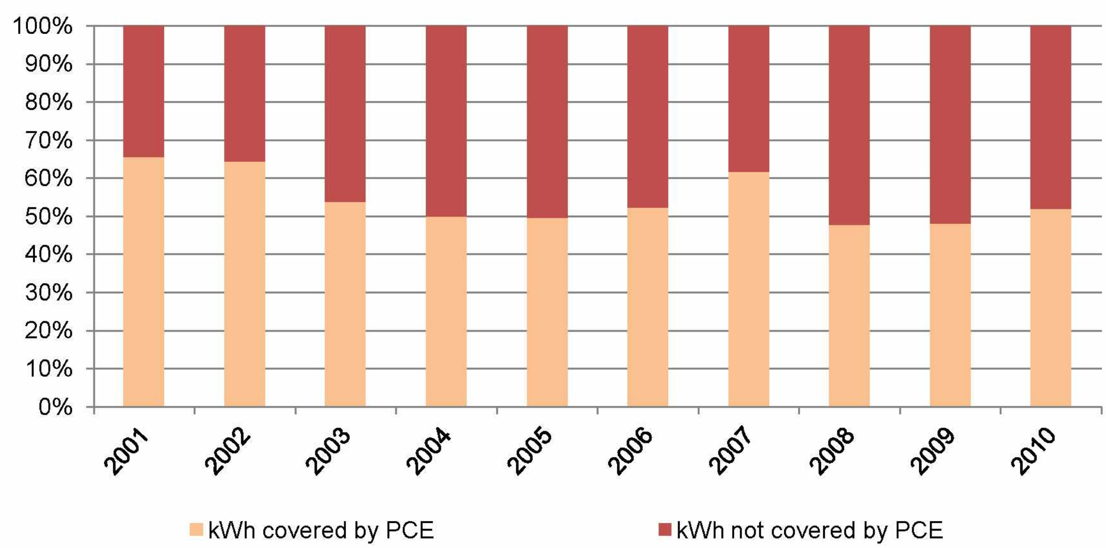

Figure 11: Community Facilities kWh Sold in PCE Communities. Source: PCE Annual Statistical Reports 1988-2010 and author's calculations.

The effect of the PCE program varies across communities depending on the proportion residential and community facilities comprise of total utility kWh sales. Figure 12 shows kWh sales by customer category by census area. Regions are organized from the largest to smallest residential customer share to illustrate the regional differences in demand composition by customer categories. It illustrates how in the census areas of

Hoonah-Angoon or Yukon-Koyukuk among others, residential and community facilities sales account for about 50% of total kilowatt-hours sold. In comparison, in census areas such as Bristol Bay or North Slope, residential and community facility sales are less than about 25% of total kilowatt-hours sold. Most of the regions on the right side of the chart with large portions of commercial customer power sales have large fish processing operations that have high electricity demands.

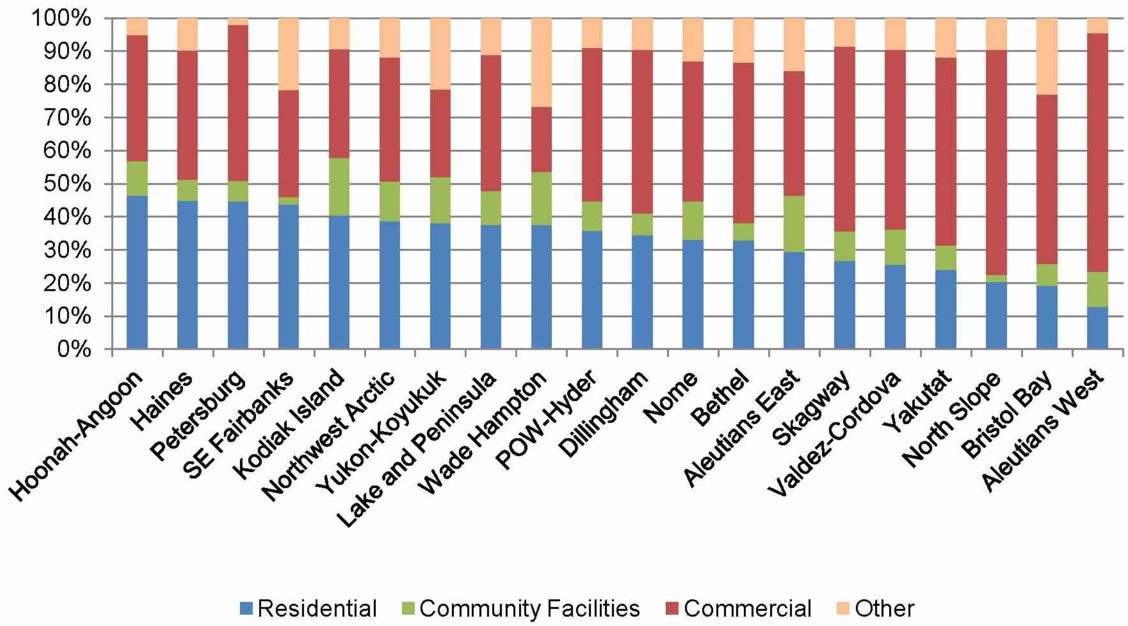

Figure 12: Kilowatt-hours Sold by Customer Category and Census Region. Source: PCE monthly program data CY 2010 and author's calculations.

Similarly, Figure 13 shows the proportion of eligible customers by region starting with the region with the largest share of eligible customers from left to right. Regions that have large industrial sectors also have lower shares of PCE eligible customers.

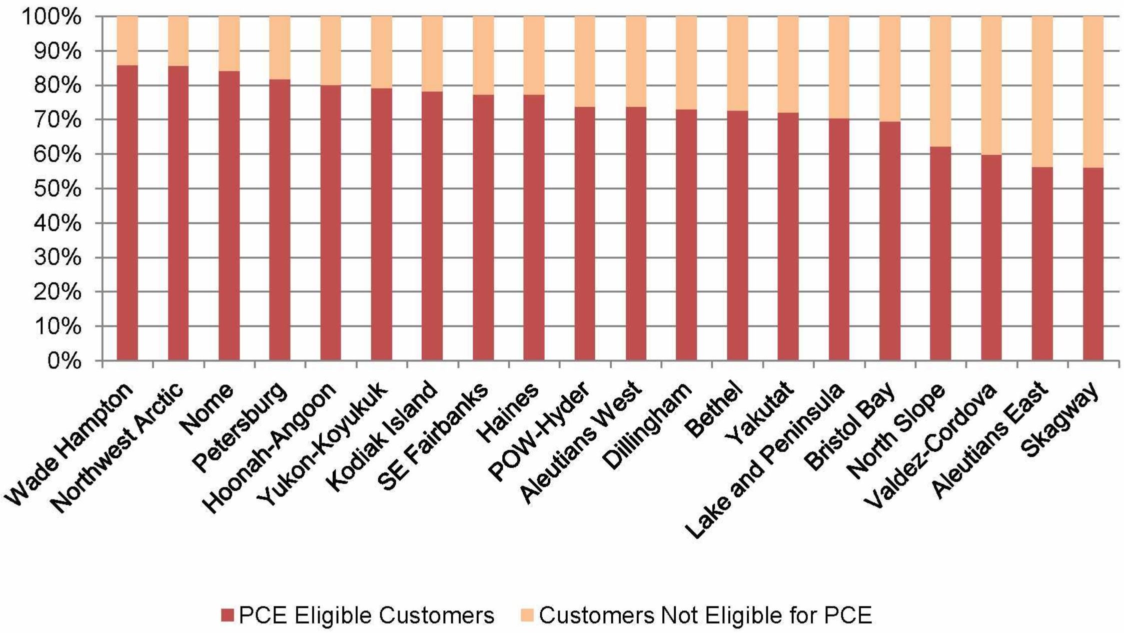

Figure 13: PCE eligible and non-eligible customers by region, CY 2010. Source: PCE monthly program data CY 2010 and author's calculations.

Figure 14 shows both the average residential and effective rates (residential minus PCE level). It exemplifies how the PCE program is fairly effective at lowering the effective residential rates for the communities served. Those regions (and communities) with higher rates receive more relief, while regions with lower rates such as the North Slope, receive a lower levels of assistance.[16]

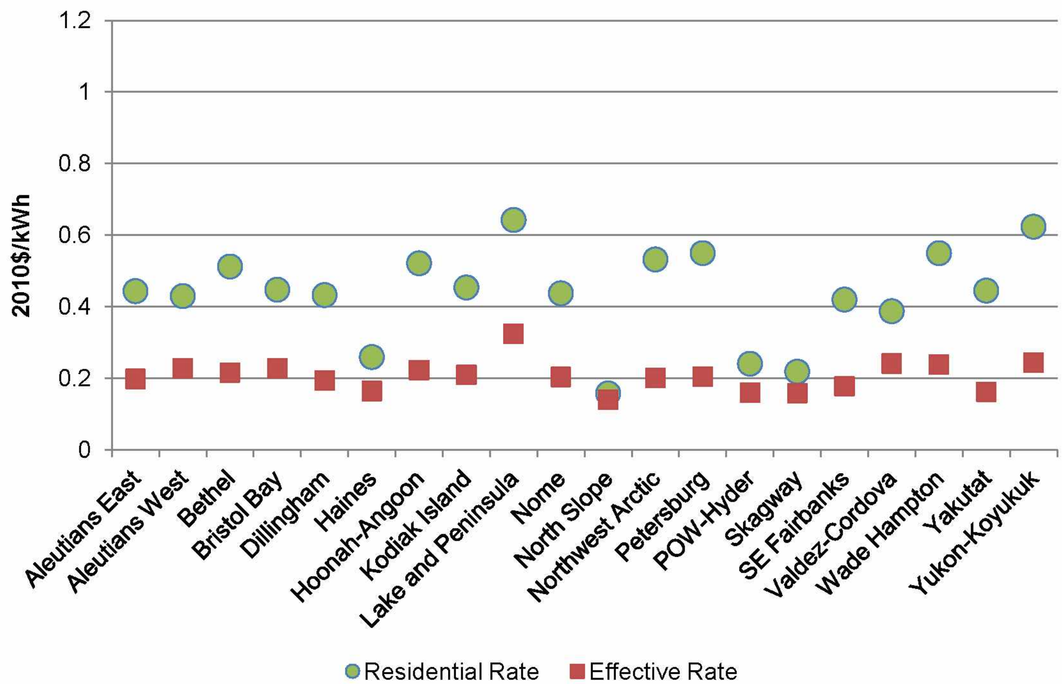

Figure 14: Average residential and effective rates of PCE communities by census region, CY2010.
Source: PCE monthly program data CY 2010 and author's calculations. Averages are weighted.

In most PCE communities average consumption per customer per month is below the 500 kWh PCE eligibility cap. Table 8 shows the different levels of consumption at various rates. During summer months in 2009, less than 18% of eligible communities had average consumption levels above the PCE cap. Most of the communities where average monthly consumption exceeded the 500 kWh cap were communities that have effective rates comparable to those in urban areas (e.g. North Slope[16]), have comparatively high incomes, and/or are located in southeast or southwest Alaska. Even during winter, about 60% of the PCE communities did not have average consumption above 500 kWh per month per customer only communities with relatively lower rates increased their consumption during the winter months (Figure 15).

[16] The North Slope Borough communities benefit from availability of natural gas in some of its communities and additional subsidies. Rate structure is a flat rate of about 15 cents per kWh for all communities in the borough.

Table 8: Average Consumption per Customer/Month in PCE communities, CY 2009

Calendar Year 2009 - Summer (April-September)					
Effective Rate	**Min**	**Mean**	**Max**	**No. Communities**	**No. Observations**
Less than $0.10	203	**294**	345	0	3
$0.10 - $0.19	107	**371**	924	57	527
$0.20 - $0.29	113	**317**	717	96	330
$0.30 - $0.39	140	**301**	486	9	84
$0.40 - $0.49	182	**303**	501	5	27
$0.50 - $0.59	69	**162**	329	2	21
$0.60 - $0.69	115	**197**	293	2	7
More than $0.70		**115**		0	1
Calendar Year 2009 - Winter (October - March)					
Effective Rate	**Min**	**Mean**	**Max**	**No. Communities**	**No. Observations**
Less than $0.10	324	**548**	816	1	6
$0.10 - $0.19	100	**432**	970	49	597
$0.20 - $0.29	92	**379**	966	101	276
$0.30 - $0.39	144	**322**	606	10	58
$0.40 - $0.49	148	**308**	506	7	37
$0.50 - $0.59	53	**138**	365	2	13
$0.60 - $0.69	81	**211**	351	2	8
More than $0.70	59	**75**	91	0	2

Source: PCE monthly program data CY 2009 and author's calculations. Note that the number of communities in the summer only adds up to 171 and not 172; this is because not all PCE communities file their monthly report year-round. In this case a community only filed during some of the winter months. Also the number of communities within a rate range is determined by taking the monthly average for the season; hence in some cases it may show a number of observations, but zero communities.

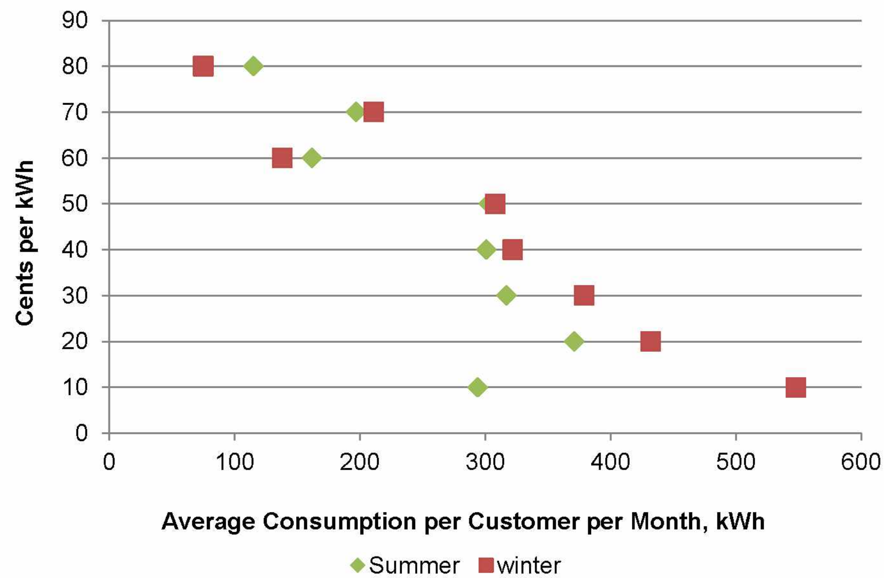

Figure 15: Electricity Consumption in PCE Communities by Season, CY 2009. Source: PCE monthly program data CY 2009 and author's calculations.

Chapter 4 Misalignment between PCE and REF

Impacts of PCE on efficiency, innovation and conservation incentives

There are three primary ways that the PCE program ultimately affects the price of electricity to rural residents, and thus efficiency, innovation and conservation incentives. One is a broad effect on prices and consumption. The second is the specific application of the current PCE formula as written in statute and applied by RCA. The third is how the savings from integrating lower[17] cost renewable resources is distributed among PCE eligible kWh, non-eligible kWh and the PCE program. Below each of these effects are discussed sequentially in detail.

General Price and Consumption Incentives

The PCE program in its current form has a range of impacts on economic incentives. Economic theory tells us that more of a normal good is consumed as prices decline. Because PCE lowers the price of electricity for eligible kilowatt-hours, it allows customers/households to purchase more electricity and utilities to supply more power than they would if they were paying the full market price. However, because the cost of producing electricity in most PCE eligible communities is very high, the residential customer rates (referred to as the "effective rates") even with PCE are still relatively very high. Comparatively high electricity rates coupled with low cash incomes result in average per customer electricity consumption of less than 400 kWh—over 40% less than the urban Alaska average of 700 kWh. While residents in PCE communities may be consuming more electricity than they would if they were paying market prices, their consumption is in the realm of "lifeline" levels barely powering what would be considered essential modern household functions such as lights and refrigeration. It appears that the primary effect of the PCE program is increasing the quality of life of rural residents rather than encouraging "excessive" use of electricity.

On the other hand, by lowering the price of electricity PCE lengthens the payback period of household investments for energy efficient products and lowers the energy efficiency incentives to households. However, this effect may be outweighed by the relatively high

[17] This is not to imply that renewable energy is always a lower cost alternative but rather to investigate the effects of the PCE formula if and when renewable energy is a lower cost alternative.

electricity prices households pay even with PCE effective rates. The larger barrier to household investments in demand side energy efficiency such as more efficient appliances and lighting is likely insufficient household income and capital to finance the upfront costs of these investments. An increase in residential energy efficiency does not necessarily result in utilities have to cope with lower electricity demand because these household efficiency gains may allow households to increase consumption over time, thus becoming more likely to reach parity with urban household consumption levels, and increasing rural quality of life.

At the utility level, there are generation efficiency and line loss standards that must be met in order to receive the full potential PCE level. If these generation efficiency standards are not met, the PCE level is lowered. In addition, utilities submit detailed documentation regarding their operating costs and RCA determines if costs are eligible. Yet, the reporting complexity and limited resources of some utilities may result in detailed operational data not being updated frequently, resulting in PCE levels being lower than necessary to cover actual utility costs.[18]

Utility generation standards provide a disincentive to generate at lower efficiencies. However, adjustments in the PCE effective rate calculations are complex and utility clerks and rate payers may not fully realize that they have forgone a portion of the PCE payment because the utility is generating power less efficiently than the standards[19]. There are also a myriad of causes of poor efficiency including old generators[20], generators poorly sized for the load, failing transmission lines and transformers, deferred and insufficient maintenance, lack of operator training, and loads that are too small to support a central generating facility, all of which are difficult for small cash strapped utilities to control or address. The Alaska Energy Authority (AEA) and other institutional support have improved this situation generally, but the needs and issues are so diverse and complex that it is difficult to see how it can be fully overcome.

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[18] Work with some rural utilities on their cost structures and limited review of PCE non-fuel cost data suggest that this issue is not uncommon.

[19] Utility clerk positions in rural utilities tend to have very high turn-over issues. Hence maintaining a well trained utility clerk that fully understands the complexities of the PCE reporting requirements and the consequences of not filing accurate information is an important and continuous challenge.

[20] Data published by the U.S. Department of Energy, Energy Information Administration suggests that internal combustion generators in Alaska are about seventeen and a half years old.

Probably the most significant incentive utilities have to operate as efficiently as possible is the fact that for most utilities, PCE eligible kWh are less than half of the total kWh sold. So a significant number of their customers are paying the full rate for all (commercial and other) or a portion of their kWh consumption (residential and community facilities). In many cases, the cost to self-generate for their commercial customers may be similar to the rates these customers are paying the utility. So the utilities are under substantial pressure to keep their rates as low as possible because losing commercial customers is likely to send the utility into a downward spiral of escalating costs and declining sales over which to spread the costs, along with declining generation efficiency as the load decreases. From the utility perspective, this results in disincentives to have either individuals or commercial customers self generate, generate renewably, or decrease their load through efficiency or conservation.

In summary, while PCE reduces the rates paid for eligible kWh, for most residential customers the effective rates are still sufficiently high and household cash incomes sufficiently low such that most customers continue to consume have electricity use. Low income and high energy costs coupled with volatile fossil fuel prices and the fiscal challenges of fully funding the PCE program, results in a high level of “energy insecurity” in most rural communities. The PCE data show that average per residential customer consumptions is well under the cap of 500 kWh. The fact that average consumption is lower than the allowable cap illustrates a degree of uncertainty by residential customers regarding if and how much reimbursement they will actually receive. For utilities, pressure from customers paying non-PCE rates probably overwhelms any effect that PCE may have on reducing the incentive to maximize generation efficiency. While the high cost of electricity may overwhelm the disincentives caused by the PCE funding formula, the PCE program does not address the fundamental barriers to improving energy efficiency and saving rate payers money in rural communities.

However, the PCE funding formula structure does result in a disincentive towards innovation and alternate sources of energy as potential solutions to the problem of high costs of rural energy because it is directly tied to fuel costs. As a result, integrating alternative or renewable generation technologies may result in a lower PCE payment causing the effective electric rates to increase. Knowing how the PCE level will change requires an individual analysis for each utility and generation alternative because alternative sources of generation affect non-fuel costs (which are also considered in the PCE formula), hence the PCE level may increase, decrease or remain the same. In other words, the new PCE level depends on how the utility cost structure changes and by how much. Considering the impact of PCE is highly situation specific and hence difficult to predict.

Fuel Cost Calculations

A decline in fuel costs affects the PCE level calculations because in the formula the total fuel costs are divided by all kilowatt-hours sold, not just the kilowatts-hours sold that were generated using diesel fuel. Table 9 shows a generic example of how dividing fuel costs by total kWh sold results in a decrease in the fuel cost variable used in the PCE level formula. Hence the way fuel costs are calculated in the PCE formula becomes a disincentive against integrating renewable generation and also increasing the penetration of renewable power generation. This results because the larger the renewable generation, the lower the fuel cost per kWh that is used in the PCE formula to calculate the PCE level. The simplified examples below should help to clarify this complexity.

Table 9: Example of PCE Fuel Costs Calculations and Its Effects on Renewable Generation

Generation from diesel, 100%		**Generation from diesel, 50%**	
Total fuel costs	$1,000	Total fuel costs	$500
Total kWh sold from diesel	10,000	Total kWh sold from diesel	5,000
Total kWh sold	10,000	Total kWh sold	10,000
Fuel costs/kWh sold from diesel	$0.10	Fuel costs/kWh sold from diesel	$0.10
Fuel costs/total kWh sold	$0.10	Fuel costs/total kWh sold	$0.05

Source: Author's calculations.

In order to illustrate how the effect of reduced fuel cost could decrease the PCE level and lead to higher effective rates for residential customers; two generic scenarios of renewable integration based on PCE program data are presented below (Figure 16). These scenarios present a review of the differences in the rate calculations between generating all electricity with diesel with generating electricity with a hybrid diesel-renewables system. The first scenario reviews the changes for a utility with high renewable penetration using hydroelectric generation. The second scenario reviews the changes for a utility with low renewable penetration using wind generation. However, the type of renewable generation is immaterial to the results.

	Scenario 1				Scenario 2			
Generation	**Diesel Only**		**Diesel-Hydro**		**Diesel Only**		**Diesel-Wind**	
Renewables generation, kWh	0		1,507,416	(90%)	0		341,956	(9%)
Diesel generation, kWh	1,682,428	(100%)	175,012	(10%)	3,866,416	(100%)	3,524,460	(91%)
Total generation, kWh	1,682,428		1,682,428		3,866,416		3,866,416	
Total kWh Sold	1,454,633		1,454,633		3,646,178		3,646,178	
Costs								
Total fuel consumed, gallons	89,307		9,290		288,771		263,231	
Average fuel price, $/gallon	2.31		2.31		2.63		2.63	
Total fuel costs, $	206,045		21,434		758,991		691,864	
Fuel cost per kWh Sold, $/kWh	0.14	(27%)	0.01	(4%)	0.21	(54%)	0.19	(51%)
Non-fuel costs, $	542,128		542,128		641,935		751,320	
Non-fuel cost per kWh sold, $/kWh	0.37	(73%)	0.37	(96%)	0.18	(46%)	0.21	(49%)
PCE Calculations								
Total costs per kWh, $/kWh	0.51		0.39		0.38		0.40	
Base rate, $/kWh	0.13		0.13		0.13		0.13	
PCE eligible costs, $/kWh	0.38		0.26		0.25		0.26	
Funding Level, $/kWh	95%		95%		95%		95%	
PCE level, $/kWh	0.36		0.24		0.24		0.25	
Rates								
Residential rate, $/kWh	0.52		0.52		0.43		0.43	
-PCE level, $/kWh	0.36		0.24		0.24		0.25	
Effective rate, $/kWh	0.16		0.28		0.19		0.18	

Figure16: Sample PCE Level Calculation Before and After Integrating Renewables. Source: PCE monthly program data CY 2009 and author's calculations.

In both scenarios total generation, total kWh sold, average fuel price and residential rates are assumed constant. Though these factors may likely change, however keeping them constant clearly illustrates the effect of fuel costs in the current PCE level formula. In the first scenario we assume that non-fuel costs remain the same (though this is unlikely in any renewable energy system[21]); and in the second scenario non-fuel costs are increased at 3 cents per kilowatt-hour. Figure 16 shows the calculations of the PCE level for both scenarios.

Scenario 1 shows a PCE utility moving from generating all electricity with diesel to having a high renewable penetration hybrid system of 90% hydroelectric and 10% diesel generation. This change leads to a decrease in fuel costs by 90%. Consequently, their total cost per kWh drops and so does the PCE level, by about 33%. The result is an increase in the residential effective rate from 16 cents/kWh to 28 cents/kWh (about 75%).

Scenario 2 shows a PCE utility moving from generating all electricity with diesel to having a low renewable penetration hybrid system of 9% wind and 91% diesel generation. This change leads to a decrease in fuel costs of about 9%. In this scenario, we assumed an increase in non-fuel costs of 3 cents per kWh sold and this leads to an increase of 17% in total non-fuel costs. After the decrease in fuel costs and the increase in non-fuel costs, the total cost per kWh increases 2 cents/kWh and the PCE level increases 1 cent/kWh. Consequently, although the residential effective rate ($0.18) decreases 1 cent/kWh (from $0.19 in the diesel only column), this decrease in the effective rate would have been larger if the fuel cost/kWh calculation in the PCE formula had only been done using kWh sold that were generated with diesel and not all kWh sold. This formula designed may be a reflection of the time when the formula was developed when it was assumed all generation would be done with diesel fuel. If fuel costs per kWh were calculated based only on the kWh sold generated with diesel, the fuel costs per kWh would have remained constant. Under this alternative application of the formula, residential customers would have seen a 17% decrease in their effective rate.

This uncertainty regarding the impact on the resulting PCE level may be a disincentive against seeking renewable sources of generation. If integrating renewable energy sources results in comparable or lower costs, this results in a clear benefit to the utility and community as a whole. Figure 17 illustrates the effects the residential customer may see in their monthly bill under the two scenarios discussed above. If these customers do

[21] Both fuel cost and non fuel cost change when the renewable energy is integrated into the generating system which change is larger and determines the effect on rates can only be determined in a case by case basis.

not realize monthly savings on their bills, a "public relations" problem is likely to result for the utility. Customers focus on their monthly bills—not the price per kWh, not their total monthly consumption, not the PCE funding formula, nor other factors but except what they must pay each month. An expected rational reaction of utilities would be to further increase non-fuel costs beyond the actual added costs from renewable energy integration to help offset the inaccurately large calculated decrease in the fuel costs portion of the formula.

	Scenario 1		Scenario 2	
	Diesel Only		Diesel-Wind	
	No PCE	PCE	No PCE	PCE
Residential Rate, $/kWh	$ 0.43	$ 0.19	$ 0.43	$ 0.18
Monthly Bill @ 400 kwh per month, $/month	$ 172	$ 76	$ 172	$ 72
Monthly Bill @ 600 kWh per month, $/month	$ 258	$ 138	$ 258	$ 133

Figure 17: Example of Effects on Customers' Bills from Integrating Renewables. Source: PCE monthly program data CY 2009 and author's calculations.

Distribution of Renewable Energy Savings

If the PCE level declines causing the effective residential rates to increase for PCE eligible kWh, PCE eligible rate payers consuming below the 500 kWh cap see little benefit on their monthly bills because the savings accrue to the PCE program, not the rate payer. Alternatively, if the PCE level remains the same, these same customers still see no change in their monthly bills. If the PCE level increases, the effective rate marginally decline providing some decrease to customer bills. But the latter only occurs if the renewable generation is more expensive than diesel fuel generation, which is counter to the purpose of integrating renewables and should not happen.

Preliminary estimates of rate effects of the renewable energy grant funded projects on effective PCE rates showed the proportion of savings to PCE eligible ratepayers was about 1-2% with the remainder of savings split between PCE ineligible ratepayers and the PCE program.[22] This preliminary estimate (Table 10) is consistent with the estimates shown in example Scenario 1 (above in Figure 16). Table 10 provides a summary example of the savings distributions from integrating renewable energy generation

[22] Alaska Energy Authority, calculations for the Renewable Energy Fund Grant program review, January 2012.

based on scenario 1 above. This example uses FY 10 PCE data to calculate the specific saving distributions across different classes of rate payers and the PCE program.

Table 10: Example of PCE Savings Distribution from Integrating Renewables

Scenario 1- Diesel-Hydroelectric		
For eligible customers (48% of all kWh sold)		**Savings distribution**
Production cost savings/kWh	$0.12	
PCE eligible kWh	692,489	
PCE program savings/kWh (based on 95%covered by PCE program)	$0.118	
Total PCE program savings	$81,798	45%
Customer savings (based on 5% not covered by PCE program)	$0.006	
Total eligible customer savings	$4,305	2%
For non-eligible customers, 100% savings (52% of all kWh sold)		
Non-eligible customers' savings/kWh	$0.12	
Total non-eligible kWh	762,144	
Total non-eligible customer savings	$94,763	53%
Total production savings from renewable energy integration	$180,866	

Source: PCE monthly program data CY 2009 and author's calculations.

Chapter 5 Measuring the Price Elasticity of Demand in PCE Communities

As policy makers consider options to tackle policy reform and make programmatic structure changes regarding electricity rates, it is critically important to understand how potential modifications may change rates and consumption patterns. Price and income elasticity of demand are very important when formulating or re-structuring pricing policies (Narayan & Smyth, 2005). Economic theory tells us that in most cases prices and consumption have an indirect relationship meaning more of a good is consumed when prices are relatively lower and less of a good is consumed when prices are relatively higher. The economic concept of Price Elasticity of Demand (PED) measures the proportionate change in quantity consumed of a good in response to a proportionate change in the good's own price (Nicholson & Snyder, 2008).

Traditionally, economists have used econometric methods to estimate the price elasticity of goods (Dilaver & Hunt, 2011; Khank & Qayyum, 2009; Narayan & Smyth, 2005). While there are a number of elasticity estimates for other regions of the nation Alaska specific price elasticity estimates for rural communities have not been developed. Because of its importance related to analyzing price structural reforms, this chapter presents a preliminary effort to measure PED in PCE communities in Alaska.

Model

Consumer demand theory provides a general framework to understand demand of goods and services. Consumers have the willingness and ability to purchase a range of quantities of a good given a range of prices. In a consumer demand model price, income, taste and preferences, and the prices of substitute and complementary goods affect quantity demanded (Nicholson & Snyder, 2008). Economists have produced a vast literature specifically on what are the electricity of demand factors; namely household electricity consumption is understood to be a function of the price of electricity, household income, consumer appliances and the rate at which they are used, number of users/customers, ambient temperature and seasonality (affecting the use of heating/cooling and need for lighting) (Narayan & Smyth, 2005).

For the purpose of this study, residential customer monthly electricity demand in a PCE community is assumed to be represented by:

$$EC_t = f\,(R, I, P, S)_t \tag{1}$$

where at time t, EC is the average quantity of electricity demanded as a function of R the price of electricity, I the household income, P the community population, and S as the changes in consumption due to seasonal factors.

The model does not differentiate between long-run and short-run, hence implicitly the model presented analyzes the short-run where household's electrical appliances and income are fixed, and all customers are homogeneous.

In econometrics, log-log models are commonly used to measure elasticity (Wooldridge, 2009). It is called a log-log model because the natural logarithms of the both the independent and dependent variables are used to estimate the percentage change of the dependent variable (consumption) based on the percentage change of the independent variable (price or rates). In order to estimate Alaska's PED of electricity for residential customers, regression analysis of a log-log model was used.

The estimated econometric model used is specified as follows:

$$\begin{aligned} \ln RKC_{it} = {} & \beta_0 + \beta_1 \ln RKC_{(it-1)} + \beta_2 \ln R_{it} + \beta_4 \ln R_{(it-1)} + \beta_5 \ln Y_{it} + \beta_7 W_{it} \\ & + \beta_8\, P_{500it} + \beta_9 P_{1000it} + \beta_{10} P_{2000it} + u \end{aligned} \tag{2}$$

where:

RKC represents the average monthly residential kilowatt-hours consumed per customer in community *i*

R represents the average monthly effective rate (residential rate – PCE rate) for community *i*

Y represents the fixed (CY 2004) real (2010$) average adjusted gross income for community *i*

W is a dummy variable indicating seasonality; where winter (October-March) equals one summer, and (April-September) equals zero.

P_{500} dummy variable equal to one for communities with populations between 201 and 500 people, zero otherwise.

P_{1000} dummy variable equal to one for communities with populations between 501 and 1000 people, zero otherwise.

P_{2000} dummy variable equal to one for communities with populations between 1001 people, zero otherwise.

β represents the estimated coefficient for each covariate

i represents an observation for community

t represents one time period

Methods

An Autoregressive Distributed Lag (ADL) Model was chosen to improve estimation accuracy as the data panel presented serial correlation. ADL models fall under the category of the econometric modern view of time series data that uses specifications to capture dynamic processes in the question rather than view serial correlation as a technical OLS assumption violation. ADL models include lagged dependent and independent variables in the model. Autoregressive refers to the inclusion of lagged dependent variables which results in making the effect from the previous period persist by having the impact of the unit level from the previous period added to the unit level change in the current period; and eventually the effect will disappear. Distributed lag refers to the inclusion of lagged independent variables to try to capture the explanatory value of past values of the explanatory variable. (Golder, n.d.).

The model appropriately incorporates factors such as price and income, a dummy variable ***winter*** to capture seasonality effects, and a set of dummy variables indicating the differences in size of the population to capture consumption effects due to difference in community size.

However, the fact that the model does not differentiate between short and long run is a critical consideration because based on economic literature we know that “short-run elasticities are much smaller than long-run elasticities” (Narayan & Smyth, 2005). Changing price structures have long term implications, we should expect that in the long run changes in consumption would be likely and considerably higher than those in the short term.

Measuring PED of electricity for rural Alaska communities is particularly challenging because the prices/ rates of residential customers are subsidized by the PCE program – the first 500 kWh per customer per month are a significantly lower rate than any consumption above the cap. Hence the demand curve is discontinuous. This not only means that different rates are paid for different levels of consumption but that consumer behavior factors this two different prices into their purchasing patterns—meaning that the higher price above the cap affects consumption for the kWh below the cap and that kWh consumed above the cap are affected by the consumption and prices below the cap. In most communities, there is a large discontinuity between the prices above the cap, which are much higher than the prices below the cap. Most residential customers consume below the cap (presented in Chapter 3).

Measuring the subsidy effect is exceptionally difficult because the program has existed for almost 30 years and no data is available prior to the program's existence and because all residential customers served in a community that is eligible for PCE receive the subsidy so there is no comparison group. Due to data limitations the model presented does not account for the discontinuity of the pricing structure and two way relationships the subsidy creates among both pricing structures. For the purpose of this research the elasticities are measured with respect to the price customers are currently paying for electricity – the effective rate – which is defined as the residential rate minus the PCE level (subsidy amount). Nonetheless, understanding and measuring PED of electricity is indispensable for researchers and policy makers as policy reforms are considered and using a less complex model still provided valuable analytical information.

In order to estimate PED of electricity in PCE communities, a dataset was created with price and consumption data as wells as data regarding communities' characteristics such as income, average household size and seasons. This dataset was then converted to a STATA format (a statistical software package) and missing data points were imputed[23]. In addition, based on the variable ***month*** a new dummy variable was created called ***winter***. For the winter variable, the value of zero was given to all observations with months from April to September and the value of one to all observations with months from October to March. The final dataset used in the model is an unbalanced

[23] The STATA 'impute' command was used. Missing values of the dependent variable (variable being imputed) are computed based on a list of variables (independent variables). For example, the missing values for average residential kWh consumption were imputed based on population, census region, month, amount of diesel generation and residential rate. For the residential kWh consumption (173/18647) observations and for residential rate (23/18647) observations were missing a careful review of the summary statistics of both original and imputed variable was performed to verify that the range and distribution of values were of as similar as possible.

panel for PCE communities with price, consumption monthly data from CY2002 to CY2010, and other community characteristics.

Descriptive statistics were run for all variables as well as statistical tests to determine presence of muticollinearity[24], serial correlation,[25] heteroskedasticity[26] and whether fixed or random effects should be used in the panel data analysis. Data sources and results are described below.

Data Sources

PCE Program Data

The Alaska Energy Authority uses a proprietary database system called NAVSION where data collected from the Monthly Utility Reports are stored and financial and disbursement data are tracked. Data from the PCE NAVISION system is available from 2002 to present. This database includes variables such as sales, customers, residential and PCE rates among many other variables at the utility/community and monthly level. Hence, pricing, customer and consumption data are sourced from the PCE program data system. Having monthly data available helps improve estimates of Alaska's PED of electricity. On the other hand, because the data is aggregated at the community level and not available at the customer level, it limits the estimates interpretative value. Data availability is the primary reason why the PED model uses data at the community level and not at the customer level which would be more desirable.

PCE Data Quality

PCE program data collected through the PCE Monthly Reports is self reported by the utility. Variables such as residential and PCE electric rates, disbursements, number of customers and kilowatt-hours sold are of higher quality than other variables in the database. This information is reviewed by AEA staff against documentation submitted by the utility. Variables such as fuel and non-fuels costs, generation and others are not

[24] Multicollinearity refers to high correlation among independent variables in a multiple regression model.
[25] In a time series or panel data model serial correlation means correlation between the errors in different time periods.
[26] Heteroskedasticity means that the variance of the error term given the explanatory variables is not constant.

reviewed to the same level of scrutiny because they are not relevant to providing the disbursement to the utility and because that information is more carefully reviewed by the RCA. Because these agencies operate independently and no formal mechanisms exist to reconcile data submitted by the utilities to both agencies, data discrepancies are unfortunately common. PCE program data from AEA is more readily available and accessible than data from RCA. Fortunately, the variables used in the model are of relatively higher quality.

Other Sources

Because factors other than price also have significant effects in the levels of consumption of residential customers, an econometric model should control for as many of this factors as possible. Commonly these factors include income, household size, temperature, population, and prices of household appliances among others. However, in practice as a result of data constraints, most studies fall short of the comprehensive empirical specification; typically electricity consumption is represented as a function of price, income, population and temperature (Narayan & Smyth, 2005).

Public data regarding residents or demographics of rural Alaska communities is scarce, and even when data is available, data quality needed for statistical analysis is even more difficult to find.

Income is a critical variable when estimating PED. The U.S. Census Bureau collects and publishes many demographic data on Alaska communities including income and household size. However, data regarding income in Alaska communities is published in the America Community Survey (ACS) and only at the 5 year-average, the most recent being 2005-2009. Though ACS data allows to have data for each community, it creates limitations in the model because not only is it not monthly data like PCE consumption and pricing data but it is a five year average which may introduce measurement bias. Additionally, due to small sample size issues, ACS data has very large margins of error which are problematic and further hinder their usefulness in the model.

In 2008, the Institute of Social and Economic Research at the University of Alaska, Anchorage in partnership with the Center for Economic Development and others conducted a study researching types of small business enterprises that might be viable in different sizes and types of rural Alaska communities – the Viable Business

Enterprises for Rural Alaska (ViBEs) project. As part of this study, a database was created with includes IRS zip code level data for average adjusted gross income[27], aggregated at the community level. However, the data is only available for one year, tax year 2004, and is six years older than the most recent year of study in this analysis (2010). Nonetheless, because the income data is of critical importance, the average adjusted gross income data from the IRS zip code level data as aggregated and published by ISER was used in this model because it is more reliable for the purpose of this analysis than the median income data published by the U.S. Census Bureau-ACS. This means that in the regression dataset the variables of average adjusted gross income variable is fixed for a community over the time period of analysis. Both ACS and ViBES databases also includes data for total number of households and average household size (originally published from the U.S. Census Bureau). The average household size variable has a small range of 2 to 5 and very little variation across all observations limiting its usefulness in regression analysis. Hence instead, U.S. Census Bureau population estimates data published by the Alaska Department of Labor and Workforce Development was used in the model introduced as a set of dummy variables. In summary, data constraints limits the reliability of the model presented that can be overcome as additional and more disaggregated data becomes available that allows a more accurate estimation of the specified model. These factors however do not diminish the importance of the valuable insight that the model discussed below provides and how it improves the knowledge base regarding electricity pricing and consumption effects in rural Alaska.

Results

Diagnostic Tests

Prior to estimating the regression described above a number of statistical tests were performed to determine the appropriateness of the model. Below (Table 11) a

[27] The Internal Revenue Service (IRS) publishes household income data at the zip code level including for many Alaska communities. An effort was made to collect recent income data from the IRS, but at the time this analysis was conducted the IRS did not have the data available and neither an expected date when the data may become available.

description of these statistical tests is presented, starting with the descriptive statistics of variables of interest in the database.

Table 11: Variable Descriptive Statistics

Variable Descriptive Statistics N=18647 Variable Name	Range	Mean	Standard Deviation
Real residential rate (imputed)	(0.15, 1.98)	0.512	0.162
Real effective rate	(0.05, 1.20)	0.249	0.091
Residential kWh per month	(757, 1,210,865)	65,759	122,082
Residential kWh per customer per month	(29, 5113)	365	132
Real average adjusted gross income (VIBES/IRS CY2004, imputed)	(9,889, 64,115)	26,760	8,172
Average household size (VIBES/ACS CY2004, imputed)	(2, 5)	3.6	0.737
Total population	(8, 6,080)	451	715

The range of variables presented in this table (Table 11) provides a clear example of how differences across communities can be extremely large in all aspects, from population, income, prices and consumption. Although PCE communities share many essential challenges, they are also clearly diverse.

In addition to a review of the variables descriptive statistics, an examination of the correlation among variables used in the regression was performed and collinearity diagnostics were reviewed to examine potential presence of multicollinearity. Given the results of the test presented in Table 12, muticollinearity was not a concern when estimating the model.

Table 12: Collinearity Diagnostic Results

Collinearity Diagnostics				
Variable	VIF	SQRT VIF	Tolerance	R-Squared
ln R	1.06	1.03	0.9478	0.0522
ln Y	1.20	1.10	0.8305	0.1695
W	1.00	1.00	0.9998	0.0002
P_{500}	1.21	1.10	0.825	0.175
P_{1000}	1.24	1.11	0.8078	0.1922
P_{2000}	1.30	1.14	0.7672	0.2328
Mean VIF	1.01			
			Eigenval	Cond Index
		1	4.1921	1.0000
			1.0007	2.0468
		2	1.0000	2.0475
		3	0.4666	2.9974
		4	0.3067	3.6969
		5	0.0335	11.1887
		6	0.0003	110.7562
		7		
		Condition Number		110.7562
Eigenvalues & Cond Index computed from scaled raw sscp (w/intercept)				
Det (correlation matrix)				0.6446

Additionally, to the determine whether the panel presented serial correlation a Wooldridge test for panel data as executed in STATA was performed. The test hypothesis is that no firs-order autocorrelation exists. The test however proved significant at the 1% level leading to a rejection of the null hypothesis and a conclusion that the panel data presented autocorrelation (Table 13).

Table 13: Autocorrelation Test Results

Wooldridge test for autocorrelation in panel data	
Ho:	no first-order autocorrelation
F(1, 176)	= 56.539
Prob>F	= 0.0000

Given that the data presented autocorrelation, the dataset was tested for stationarity with a Fisher Test for panel unit root using an augmented Dickey-Fuller test. The test hypothesis is that a unit root exists. The test results (Table 14) were significant at the 1% level leading to a rejection of the null hypothesis and a conclusion that the data did not have a unit root.

Table 14: Stationarity Test Results

Fisher Test for panel unit root using an augmented Dickey-Fuller test (1)		
Ho:	unit root	
	Chi2(354)	= 2791.2487
	Prob > Chi2	= 0.0000

Moreover, to determine whether fixed or random effects should be used in the model estimation a Hausman specification test was performed. The process of this test is that estimates for the specified models are calculated under fixed effects and the assumptions that the estimated parameters are consistent under both the null and alternative hypothesis. Then estimates for the specified model are calculated under random effects and the assumptions that the estimated parameters are inconsistent under the alternative hypothesis but efficient under the null hypothesis. Finally a Hausman test is done for the null hypothesis that the difference in coefficients is not systematic. The test was significant at the 1% level hence rejecting the null hypothesis and concluding that fixed effects are more appropriate for this model (Table 15). By using fixed effects the unobserved effect is allowed to be arbitrarily correlated with the explanatory variables in each time period. Fixed effects allows the relationship between predictor and outcome to be explored within an entity (e.g. community) as each entity has its own individual characteristics that may or may not influence the predictor variables. By using fixed effects, it is assumed that something within the community may impact or bias the predictor or outcome variables and we need to control for this.

Table 15. Fixed or Random Effects Test

Hausman Specification Test				
	----------Coefficients--------			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
Variable	Fixed	Random	Difference	S.E.
ln $RKC_{(t-1)}$	0.4645295	0.8066271	-0.3420977	0.0046319
ln R	-0.0334138	-0.4113124	0.0078986	.
ln $R_{(t-1)}$	-0.0171829	-0.131211	-0.0040618	.
ln Y	0.1238014	0.0381254	0.085676	0.016682
W	0.1047754	0.0614583	0.0433171	.
P_{500}	0.0120607	0.0549379	-0.0428772	0.0097884
P_{1000}	0.0393692	0.0624882	-0.0231189	0.0165689
P_{2000}	0.0702155	0.0729332	-0.0027177	0.0317757

	b=consistent under Ho and Ha; obtained from xtreg
	B=inconsistent under Ha, efficient under Ho; obtained from xtreg
chi2(5)	= (b-B) ' [(V_b-V_B) ^ -1] (b-B)
	= 5747.86
Prob>chi2	= 0.0000
	(V_b-V_B is not positive definite)

Finally, the dataset was also tested for presence of heteroskedasticity using a modified Wald test for groupwise heteroskedasticity in fixed effect regression model. The null hypothesis is that homoskedasticity exist. The test was significant at the 1% level hence rejecting the null hypothesis and concluding that heteroskedasticity exists (Table 16). Consequently, robust standard errors are reported for the model estimation.

Table 16. Heteroskedasticity Test

Modified Wald test for groupwise heteroskedasticity in fixed effect regression model	
Ho:	sigma(i)^2=sigma^2 for all i
Chi2 (177)	= 5684.16
Prob > chi2	= 0.0000

Regression Results

The model estimates residential kilowatt-consumption per customer at a rural village as a function of the real effective rate customers pay, the average real adjusted gross income in a village (fixed), the difference in consumption from the prior month, a lagging consumption effect from the previous period, a lagged price effect from the previous period, changes in consumption due to seasonality and community population size. Table 17 (page 60) shows the regression estimation output.

All variables in the model are statistically significant with the exception of the P_{500} variable. Introducing the lagged residential consumption per customer in the model has the purpose of addressing serial correlation in the data. It accounts for shocks in unmeasured variables that have a long term impact on residential consumption per customer per month. The effect of these unmeasured variables persists over time but the effect of measured variables does not persist. The variable is significant meaning these shocks exist and they have a positive relationship with consumption; in other words they increase residential kWh consumption per customer per month. However, these effects disappear over time.

As expected, the price elasticity of demand is negative and highly inelastic. A 1% increase in the real effective price results in a 0.03% decrease in residential kWh consumption per customer per month. In addition, the lagged real effective rate from 2 time periods past have a negative effect in the residential kWh consumption per customer per month consumed in the present time. For example a real effective rate increase has the effect of decreasing consumption in two time periods later, but at a diminishing rate.

Table 17: Regression Output

Regression Output						
Fixed-effects (within) regression			Number of observations		=	18318
Group variable:	featureid		Number of groups		=	177
R-squared:	within:	0.3902				
	between:	0.9453	Obs per group:	min	=	12
	overall:	= 0.7572		avg	=	103.5
				max	=	113
				F (5, 176)	=	379.34
	corr (u_i,Xb)	= 0.7270		Prob > F	=	0.0000

ln RKC	Coefficient	Robust Standard Error	t	P >| t |	[95% Confidence Interval]	
ln $RKC_{(t-1)}$	0.4645295	0.0256469	18.11	0.000	0.4139145	0.5151445
ln R	-0.0334138	0.0095676	-3.49	0.001	-0.0522959	-0.0145318
ln $R_{(t-1)}$	-0.0171829	0.009876	-1.74	0.084	-0.0366736	0.0023077
ln Y	0.1238014	0.0409927	3.02	0.003	0.042901	0.2047018
W	0.1047754	0.0082766	12.66	0.000	0.0884412	0.1211096
P_{500}	0.0120607	0.0147967	0.82	0.416	-0.0171411	0.0412626
P_{1000}	0.0393692	0.0218759	1.8	0.074	-0.0038036	0.082542
P_{2000}	0.0702155	0.0219741	3.2	0.002	0.0268488	0.1135822
β_0 *(constant)*	1.725982	0.4502192	3.83	0.000	0.8374588	2.614505
sigma_u	0.15425644					
sigma_e	0.14797145					
rho	0.52078654	(fraction of variance due to u_i)				

Also as anticipated, income price elasticity is positive but also inelastic. A 1% increase in the real average adjusted gross income in a community results in an increase of 0.12% increase in residential kWh consumption per customer per month. Increases in income shift the demand curve to the right.

Seasons are also an important factor. The difference in residential kWh consumption per customer per month due to seasonal changes is significant. The regression results indicate that residential customers consume 11.05% more kWh per month during the winter; and so the demand curve shifts to the right during the winter months.

Differences in the community size also have explanatory value. Communities with populations between 201 and 500 people consume about 1.21% more than small communities with population sizes of 200 people or less. However, this difference did not show to be statistically significant. On the other hand, communities with populations between 501 and 1000 people consume about 4.02% more than small communities with population sizes of 200 people or less. This difference showed to be statistically significant at less than the 10% level. Finally, communities with populations of more than 1001 people consume about 7.27% more than small communities with population sizes of 200 people or less. This difference showed to be statistically significant at the 1% level.

In this model the constant (β_0) represents the changes in residential kWh consumption per customer per month when there is no change in any of the factors specified in the model. Because the regression is based on a log-log model that means that the logarithm of consumption is equal to 1.75. Hence in if there is no change in the specified variables residential kWh consumption per customer per month is equal to $e^{1.75} \approx 6$ kilowatt-hours effectively a very small amount.

As estimated by the model described above, price elasticity of demand for electricity in PCE communities is as anticipated and consistent with the literature (Table 18), negative and inelastic.

Unlike the examples presented in Table 18, the estimated PED for PCE communities is highly inelastic, in fact almost perfectly inelastic (-0.03). Hence, any change in price will not result in to a substantial change in the average level of consumption per customer.

It may be that the price elasticity for electricity may appear to be so inelastic for PCE communities because not only there is a lack of substitutes for (or lack or alternative sources to produce) electricity among this communities but also because the majority of these communities are consuming electricity at minimum levels and their ability to reduce consumption if price increase is limited; so instead their consumption of other goods may be sacrificed to maintain the existing level of electricity consumption.

Table 18: Examples of Residential Price Elasticity of Demand for Electricity in the Literature

Title	Location	Description[28]	PED Findings
The demand for electricity in Pakistan (Khank & Qayyum, 2009)	Pakistan	Examines aggregate and household electricity demand; short-run and long-run price elasticities.	PED negative and inelastic. Short-run (-0.167) Long-run (-0.25)
Turkish aggregate electricity demand: an outlook to 2020 (Dilaver & Hunt, 2011)	Turkey	Investigates Turkish aggregate electricity demand.	PED negative and inelastic. (-0.11)
The residential demand for electricity in Australia: an application of the bounds of testing approach to cointegration (Narayan & Smyth, 2005)	Australia	Estimates residential electricity demand; short-run and long-run price elasticities .	PED negative and inelastic. Short-run (-0.541) Long-run (-0.263)
The short-run residential demand for electricity (Barnes, Gillingham, & Robert, 1981)	U.S.	Estimates short-run price elasticity of residential demand for electricity. (In-depth analysis by end-use)	PED negative and inelastic. Overall (-0.55)

Alternatively, it may be that if prices decrease PCE residential customers are not able to significantly increase their consumption due to the inflexibility and strong effects of other constraints such as low incomes, aging or inadequate infrastructure and limited stock and low use rate of electrical appliances. PED findings at the aggregate level in the Khank & Qayyum study implied electricity to be a necessity for the urban population but a luxury good for the rural population (2009). It's possible that a similar phenomenon may be true for PCE residents where although electricity may not necessarily be luxury good, nonetheless it may require significant increases in disposable income to drive higher consumption of electricity as electricity competes with other essential goods for the household income.

Below Table 19, presents examples of expected average change in average consumption per customer in the short run for a selected group of communities if prices were to equalize to the average urban rates of about 14 cents/kWh given the estimated

[28] These descriptions are narrow summaries that are only concerned with the aspects of the research that are being compared in this table and not the comprehensive research questions of the authors.

price elasticity of demand of 0.03%; despite large decreases in prices, changes in consumption are minimal.

Table 19: Expected Consumption for Selected Communities

Community Name	Effective Rate in CY 2010 cents/kWh	Mean Consumption in CY 2010 kWh per customer	Change in Price percent	Expected Consumption kWh per customer
Allakaket	19.5	244	-39%	247
Bethel	17.9	510	-28%	514
Lime Village	94	87	-571%	102
Hoonah	20.4	412	-46%	418
Saint Mary's	31.1	383	-122%	397

Some important policy implications of the price elasticity being so highly inelastic are that electric rate reductions from changes in policy may not lead to significant consumption increases rapidly. Alternatively, policy changes that lead to large electric rate increases will force household budgets to sacrifice consumption of other goods in their basket to continue their electricity consumption similar to current levels. In addition, this underlines the importance of the subsidy structure to minimize the distortion of market price signals as much as possible. It is critically important that as fuel oil prices and generation costs continue to increase over time leading to higher electric rates, that the PCE structure disincentives towards efficiency and innovation be removed or minimized so that residents are better able to cope with increasing price of inputs and better able to pursue alternative and more cost effective sources of electricity generation. The following chapter presents a preliminary effort to show how the PCE subsidy may continue to provide need economic assistance in PCE communities while minimizing distortions of market signals.

Chapter 6 Aligning PCE and REF

Alternative PCE formula

It is imperative that the current PCE formula be revised to eliminate or reduce the energy efficiency and renewable energy disincentives created by the current PCE funding formula.

International energy subsidy reform guidelines published by the United Nations in which it states that “a good subsidy is one that enhances access to sustainable modern energy or has a positive impact on the environment, while sustaining incentives for efficiency delivery and consumption” (UNEP, 2008). These guidelines suggest basic principles needed in implementing reforms to existing programs. Namely, a subsidy should be well-targeted, efficient, practical, and transparent among other features.

When analyzing alternative funding formulas and comparing them to the current PCE funding formula, the following parameters are key to evaluate whether the alternatives are improvements over the current system:

- ✓ Improves market signals
- ✓ Does not penalize increased energy efficiency or integration of renewable energy
- ✓ Has an equitable distribution across households
- ✓ Does not decrease the current distribution of funds to a community
- ✓ Simplifies administration for utilities and state agencies and enhances understanding by customers/rate payers
- ✓ Simplifies formula and information needs for implementation

Previous research illustrates the impacts different types of economic assistance structures have on incentives. In 1987, an important conceptual review of potential structures of the PCE program was completed for the Governor’s Energy Policy Task Force (Mitchell 1987). In this review, Mitchell analyzed and ranked various program structures and funding formulas with respect to maintaining utility and customer market signals and economic incentives (Table 20). This research evaluated incentive effects of a subsidy program by analyzing what proportion of electricity generation cost savings are kept by the utility under various program structures (Table 20, Utility Incentive). Customer incentives were evaluated by analyzing the proportion of cost reductions from energy conservation measures kept by the customer (Table 20, Customer Incentive). According to Mitchell's research under a Fixed Payment Formula utilities are able to keep 100% of the benefit from generation cost savings, and customers are able to keep 100% of the benefits from savings through energy conservation measures they implement. This research extends Mitchell's analysis by defining a specific formula.

Table 20. Summary of incentive effects

Program	Utility Incentive	Customer Incentive
PCE Rate [current]	13%	33%
PCE Formula Rate	100%	significantly less than 33%
Shared Savings Rate	58%	less than 33%
Baseline Rate	58%	75%
Postage Stamp Rate	8%	33%
Fixed Payment Formula	100%	100%
Fixed Payment Cost	58%	100%
Fixed Payment Formula - No Excess	100%	75%

Source: Table recreated from The Effect of Electricity Subsidy Programs on the Economic Incentives for Improving Generation and End-Use Technologies, A comparison of Power Cost Equalization and Alternatives; prepared for the Governor's Energy Policy Task Force, Alan Mitchell, 1987.

The current PCE program uses a rate/cost formula to calculate PCE reimbursement rates. The key variables in the current PCE formula for calculating rates are non-fuel costs, fuel prices and consumption. Under a formula rate program, the calculated rate is then applied to the eligible amount of kilowatt-hours to determine the PCE payment. The PCE program focuses on factors of the variable cost of power resulting in a program that it is clearly unsustainable given the continued increase of fuel costs. Since the year 2000 fuel prices have increased by 10% annually; from 2000 to 2010 fuel prices increase a staggering 132% (see Figure 1 in Chapter 1). Hence cost of generating electricity in rural communities is increasing rapidly. In order to provide economic assistance at the same share it currently does, funding for the PCE program would need to constantly increase; however this is fiscally implausible. On the other hand if program funding does not increase or does not increase as fast as needed, increases in the effective rate residential customers pay is inevitable. Yet as presented in the previous chapter (Chapter 5) price elasticity for electricity of PCE residential consumers is highly inelastic. Consequently, the potential inability of the State to continue to fund the program, or efforts to seek program savings, would translate into substantial costs shift to the residential customers and/or utilities thereby exacerbating the access to electricity problem the program is trying to address. The costs shift is transferred almost entirely to the residential customer. For example, assume that the PCE program cannot sustain the necessary funding growth or that program savings are achieved through funding reductions, if the community of St. Mary's (Table 19, Chapter 5) effective rate increases by 10% (from $0.311/kWh to $0.3421/kWh), their consumption will increase only by one kWh (from 383 kWh/month to 384 kWh/month). However, their monthly bill would increase by $12.25 or 9.3% in effect becoming the bearer of the cost.

It is for these reasons that it is essential that policy focuses on addressing the issues regarding cost of production and targets its support to capital investments that lower the cost of generation rather than variable costs. The REF program is an example of how the State has attempted to provide such support to utilities. By modifying the PCE Level formula such that the disincentives and uncertainty of pursuing alternative and cost effective sources of electricity generation be removed, the PCE program and the REF program could be aligned and achieve both the goal of providing economic assistance to rural consumers and pursue innovation and alternative solutions that can alleviate the challenge of providing electricity in rural communities.

Such an alternative may be a Fixed Payment formula which provides a payment per given time period independent of rates and consumption. The fixed payment, however, can vary by community and be determined based on the differences in prices customers pay or the cost of producing electricity.

Seasonal Fixed Payment Formula

A potential alternate PCE Fixed Payment formula structure can have the effect of removing the disincentives found in the current PCE formula. One example of a formula design may be a fixed payment formula based on the per gallon price of fuel in a community, a generation efficiency rate, and the mean seasonal household monthly kWh consumption level. A fixed payment is calculated by dividing the price per gallon of fuel oil in a particular community (regardless of whether they generate their power with fuel oil or other sources; fuel price is used as a proxy to measure how much more costly it is to generate in one village compared to others) by a fixed generation efficiency of 14 kWh per gallon. This factor is then multiplied by the seasonal mean monthly residential consumption.

[(Fuel price $/gallon) ÷ (kWh/gal)] *Average monthly consumption per season

Figure 18: Seasonal Fixed Payment Formula.

The resulting fixed payment would be applied to the rate payer's bill every month and paid to the utility. However, to accommodate changes in seasonal consumption needs, the fixed payment would change by season so that during the summer months (April-September) the customer receives a lower fixed payment reflecting lower seasonal consumption levels, and in the winter months (October-March) the fixed payment would be higher reflecting higher winter consumption (about 11% according to the model presented in Chapter 5).

Because the payment does not depend on the amount of fuel consumed and the customer receives payment regardless of consumption or rates, household and generation energy efficiency and renewable energy incentives are reestablished. If the utility is able to produce energy at lower cost through gains in demand or supply side efficiency or using renewable energy, the benefits to the utility and customer increases. This formula structure is particularly simple and significantly decreases the administrative burden rural utilities face to file for PCE payments with the RCA and AEA. Because of its simplicity, the administration of the program could potentially be given to a single agency resulting in lower administrative costs to the state.[29]

An important feature of this potential Seasonal Fixed Payment formula is that if the customer has an electric bill lower than the fixed payment, the balance could be carried over to future months as a credit. At the end of the year if the customer has a net credit, there are a number of options that the program could offer to customers. For example, the customer could use the credit to purchase more energy efficient appliances and/or

[29] Additional research is needed to estimate and analyzed the amount and areas where savings can occur.

lighting products, transfer the credit to a relative in the village who may need it, or simply carry it forward to the following year.

Efforts should be made to improve the PCE formula design with this type of fixed payment structure and to ensure efforts to address the energy challenges in rural Alaska are coordinated. A formula of this structure may be implemented in a way that total residential disbursements remain similar to the current PCE funding formula. However, it is inevitable that effective rates at the community and customer level may change.

In order to accurately analyze potential policy and/or programmatic changes such as the one described reliable estimates of price and income elasticities are necessary. The findings presented in this research provide a formalized measure of price and income elasticities that expands the current knowledge base regarding the electricity market in PCE communities. These findings can be of value to researchers and policy makers as they analyzed potential policy reforms and programmatic changes.

Chapter 7 Policy Considerations

Coordinating State Policy and Programs

The PCE program is critical to many rural residents; restructuring the program to improve its effectiveness and efficiency is complex. There are no simple solutions to addressing the problems of high costs that rural utilities and residents face. In seeking solutions to these issues, it is important to approach the PCE program in the context of total energy use in rural Alaska. The PCE program alone has not and will not solve the fundamental issues that result in high cost energy and the impacts this has on rural residents.

Most PCE communities depend on fuel oil for both electricity generation and space heating. Consequently, high fuel oil prices increase both the cost of electricity and space heating, thus magnifying the pressure on households. Space heating is a larger share of household energy expenses (40%) than electricity, followed by transportation (33%), Figure 19, (Colt, 2011). PCE provides important relief on electricity rates; however only about 27% of fuel consumed in PCE communities is used to produce electricity (Figure 19). In addition, only about 30% of kWh used in eligible communities is affected by PCE effective rates—so the PCE program only touches about 10% of the energy picture in rural Alaska.

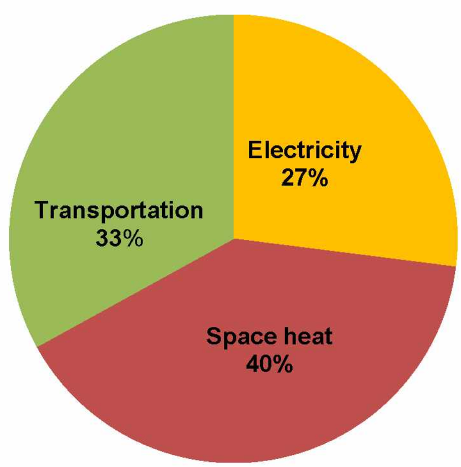

Figure 19: Energy use in surveyed PCE communities by category. Source: Energy Use the Big Efficiency Picture. Presentation at the Alaska Rural Energy Conference by Steve Colt (2011), ISER.

This composition of energy use is reflected in the course of this and other rural energy research which we found a high level of “energy insecurity” expressed by rural residents. Given volatile and unpredictable energy prices and past changes in legislative funding of the PCE program, many residents are understandably concerned about the ability to stay warm, gather subsistence resources and keep the lights on. Reviewing and improving rural energy programs must be done from a “whole village energy” perspective.

From a whole village perspective, one of the first objectives is to assist rural residents to be as energy efficient as possible to reduce the impacts of energy price volatility while maintaining or improving quality of life and reducing anxiety over energy security. In addition to the current on-going weatherization efforts in rural communities, energy efficiency and conservation could be maximized to fulfill this objective. This does not mean that new efficiency and conservation programs are needed but instead existing programs can be better coordinated and delivered—when a home or building is weatherized, it can also be retrofitted to improve electrical efficiency. Commercial and public building can be weatherized and electrical energy efficiency measures installed simultaneously with residential housing weatherization and rebate programs.

A recent weatherization and electrical retrofit on 13 community buildings and four teacher housing units in Nightmute was done as a concurrent effort. This more comprehensive and integrated effort resulted in estimated annual electric power savings of 59% and thermal energy savings 56% (Butler 2010). It is likely residential buildings experience similar savings and whole village efforts could produce substantial energy saving for residents, public buildings, businesses and schools. Realizing these substantial demand side efficiency gains is a first step to solving the challenge of high rural energy costs for residents. It logically proceeds addressing supply side generation, either fossil fuel, renewable or disaggregated, because the generation capacity would be inappropriately sized for the demand and continue to overcapitalize generation resulting in generation inefficiencies. These actions could take place in concert with the assistance that a re-formulated PCE program can provide.

Centralized versus Disaggregated Generation

Power Cost Equalization eligibility depends on having a centralized utility. As a result, for some of the smallest communities there is an incentive to over capitalize electricity generation despite the potential for less capital intensive solutions. Institutional mechanisms that emphasize conventional solutions "…raises the propensity to ignore decentralized supply options" (Hourcade & Colombier, 1990). For communities with very small populations, a traditional centralized utility may translate to higher cost power as compared to disaggregated generation because of the added cost of administration, transmission lines, and building necessary redundancy into the system among other costs that could potentially be avoided through disaggregated generation, though each individual household may experience differing degrees of reliability and access to power. If economic assistance for electricity was not restricted to centralized utilities, villages could organize through their local tribes or government to create mechanisms to support current or alternative ways of disaggregated generation that may be less costly to operate. It may also result in job creation that can be more compatible with the subsistence life styles of many rural residents and potentially more sustainable in the long run. Further research is necessary to determine the population size and other circumstances at which a rural village may be able to access lower cost electricity through disaggregated self- generation rather than opting to run a centralized utility.

Conclusions

Price and consumption patterns in rural communities participating in the PCE program are considerably different and span over a wide range. These differences are a reflection of access to resources and infrastructure and their opportunity to have gains in economies of scale. Generally, these communities pay much higher prices and consume far less than urban communities in Alaska.

The PCE program was created over 25 years to provide economic assistance to rural customers facing high electricity prices. Although the program has been relatively effective in lowering prices closer to urban prices, the financial sustainability of the program its fragile and it's reflected by in the number of years the State has not been able to fully fund the program and having to resort to pro-rating the subsidy. In addition, its funding structure has important implications on incentives for rural utilities/communities to pursue alternative sources of electricity generation that may be more cost effective. When integrating alternative sources, due to the way fuel costs are accounted for in the formula may lead to increase in the residential effective rate even if the alternative resource may be more cost effective. Also, when savings are achieved, whether by gains in efficiency or by integration of alternative sources, most of the savings accrue to the program rather than to the residential customer thereby affecting customers' incentives.

The PCE program effects on incentives on efficiency and integration of alternative sources has been accentuated since the State implemented the REF program which has the goal of incentivizing renewable energy development in Alaska. Many rural communities have received grants through the REF program for projects integrating renewable energy into their electricity generation system; in rural Alaska wind development has experience rapid growth since the establishment of the REF program. It is important that state programs have congruent goals and incentives not only because of fiduciary responsibility but also because having a coordinated approach to the complex challenges facing rural Alaska communities is critical.

Little is known about rural Alaska energy needs, consumption and prices. Lack of data availability and data quality necessary for rigorous analysis is a major barrier to insightful research and policy analysis. Although electricity consumption represents the smallest share of energy use in PCE communities, because of the PCE program there is relatively more information available regarding electricity consumption and prices. Nonetheless, no estimates of the price elasticity of demand in PCE communities have been previously done. Although the preliminary effort presented in this paper is imperfect, it provides insightful information and a base to improve elasticity estimates as additional and more disaggregated data becomes available.

Understanding electricity and energy demand in PCE communities is critically important when evaluating potential program reforms and to help find better alternatives to address challenges faced in rural communities. It is also vital to policy analysis and aims to evaluate existing programs so that programs can be better coordinated and potentially create synergies that help address energy challenges rural communities face.

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Appendix A: PCE Program Funding Levels over Time

Program	Fiscal Year	Average Annual PCE Funding Level	PCE Funding Level Detail: PCE Level	No. of Months	PCE Level	No. of Months	PCE Level	No. of Months	PCE Level	No. of Months
PPCA	1981	100%	100%	12						
PCA	1982	100%	100%	12						
PCA	1983	100%	100%	12						
PCA	1984	100%	100%	12						
PCA / PCE	1985	100%	100%	12						
PCE	1986	100%	100%	12						
PCE	1987	100%	100%	12						
PCE	1988	100%	100%	12						
PCE	1989	100%	100%	12						
PCE	1990	100%	100%	12						
PCE	1991	100%	100%	12						
PCE	1992	82%	100%	1	80%	11				
PCE	1993	89%	80%	1	90%	11				
PCE	1994	95%	90%	2	95%	8	100%	2		
PCE	1995	98%	100%	10	85%	2				
PCE	1996	98%	85%	2	100%	10				
PCE	1997	85%	85%	12						
PCE	1998	85%	85%	12						
PCE	1999	83%	85%	10	74%	2				
PCE	2000	100%	100%	12						

			PCE Funding Level Detail							
Program	Fiscal Year	Average Annual PCE Funding Level	PCE Level	No. of Months	PCE Level	No. of Months	PCE Level	No. of Months	PCE Level	No. of Months
PCE	2001	98%	100%	11	74%	1				
PCE	2002	80%	92%	7	80%	4	66%	1		
PCE	2003	86%	84%	8	90%	3	92%	1		
PCE	2004	82%	92%	3	83%	6	75%	2	63%	1
PCE	2005	72%	81%	2	76%	5	65%	4	63%	1
PCE	2006	88%	81%	4	78%	3	100%	5		
PCE	2007	95%	100%	6	89%	6				
PCE	2008	100%	100%	12						
PCE	2009	100%	100%	12						
PCE	2010	100%	100%	12						

Appendix B. PCE Appropriations and Disbursements over Time

Program	Fiscal Year	Appropriations ($)	Total Disbursements ($)
PPCA	1981	2,657,600	2,183,168
PCA	1982	9,300,000	6,419,408
PCA	1983	8,300,000	8,327,152
PCA	1984	8,300,000	8,740,820
PCA/PCE	1985	19,100,000	13,800,868
PCE	1986	21,700,000	17,785,390
PCE	1987	13,840,299	16,771,338
PCE	1988	15,067,900	17,018,680
PCE	1989	19,724,000	17,104,631
PCE	1990	16,814,000	17,785,256
PCE	1991	16,912,100	19,607,435
PCE	1992	15,029,700	15,731,165
PCE	1993	18,026,700	17,341,042
PCE	1994	17,920,000	17,516,024
PCE	1995	18,635,000	18,493,448
PCE	1996	19,385,600	19,201,515
PCE	1997	18,500,000	17,906,275
PCE	1998	18,700,000	18,503,992
PCE	1999	18,050,000	17,949,524
PCE	2000	15,700,000	14,415,676

Program	Fiscal Year	Appropriations ($)	Total Disbursements ($)
PCE	2001	17,090,222	17,076,203
PCE	2002	15,700,000	15,469,105
PCE	2003	15,700,000	15,448,480
PCE	2004	15,700,000	15,617,225
PCE	2005	15,700,000	15,370,599
PCE	2006	22,020,000	21,494,137
PCE	2007	25,619,000	25,437,093
PCE	2008	28,560,000	28,137,549
PCE	2009	38,500,000	37,029,584
PCE	2010	37,660,000	30,627,339
PCE	2011		

Appendix C. PCE communities characteristics of importance as factors of electricity production and demand[30]

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Adak	Aleutians West (CA)	0.73	0.23	3.55	5.47	258	105	2*	64,453*
Akiachak	Bethel (CA)	0.64	0.24	3.72	15.05	306	624	4	41,459
Akiak	Bethel (CA)	0.64	0.32	4.55	12.45	238	339	4	30,372
Akutan	Aleutians East	0.33	0.14	3.22	8.89	394	812	2	39,049
Alakanuk	Wade Hampton (CA)	0.63	0.20	3.90	13.55	417	695	5	30,483
Allakaket	Yukon-Koyukuk (CA)	0.71	0.19	4.38	13.56	237	105	2*	23,824*
Ambler	Northwest Arctic	0.76	0.21	4.47	14.13	398	258	4	50,330
Anaktuvuk Pass	North Slope	0.16	0.14	5.20	11.52	604	309	3	60,743
Angoon	Hoonah-Angoon (CA)	0.48	0.20	2.78	14.08	412	450	3	34,550
Aniak	Bethel (CA)	0.75	0.27	3.62	13.39	452	494	3	48,450
Anvik	Yukon-Koyukuk (CA)	0.68	0.19	4.17	11.92	327	72	3	24,587

[30] Income and household data are originally sourced from the Internal Revenue Service for the Viable Business Enterprises for Rural Alaska project by ISER and other partners (http://ced.uaa.alaska.edu/vibes/VIBESsummary.pdf). The Income and household data represent calendar year of 2004 and adjusted to 2010 dollars. Although more recent data is available through the U.S. Census Bureau America Community Survey (ACS), we present older data because we believe it is more accurate. ACS data is available as a 5 year average and is the result extrapolation of sampled data. However, due to the challenges of small samples in Alaska, ACS tends to have very large margin of errors severely limiting its value. When data from the VIBES project was not available, ACS data is presented; this is indicated by the asterisks next to the data point.

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Atka	Aleutians West (CA)	0.71	0.24	4.19	10.79	395	63	3	35,796
Atmautluak	Bethel (CA)	0.78	0.37	3.59	6.98	340	269	5	43,871
Atqasuk	North Slope	0.19	0.18	3.00	8.39	783	212	4	77,065
Beaver	Yukon-Koyukuk (CA)	0.56	0.14	3.80		195	73	3	33,264
Bethel	Bethel (CA)	0.50	0.16	5.05	13.76	505	5,966	3	66,321
Bettles	Yukon-Koyukuk (CA)	0.62	0.19	2.65	12.13	382	13	3	57,128
Brevig Mission	Nome (CA)	0.60	0.19	4.00	14.21	418	358	4	25,310
Buckland	Northwest Arctic	0.53	0.23	5.00	11.42	523	392	5	44,352
Central	Yukon-Koyukuk (CA)	0.61	0.31	2.27	10.82	167	96	2*	14,278*
Chalkyitsik	Yukon-Koyukuk (CA)	0.97	0.59	4.18	10.59	123	71	2	18,801
Chefornak	Bethel (CA)	0.64	0.26	4.13	12.95	424	430	5	41,139
Chenega Bay	Valdez-Cordova (CA)	0.47	0.17	3.30	6.64	343	80	4	62,190
Chevak	Wade Hampton (CA)	0.66	0.19	4.03	12.87	430	931	5	31,095
Chignik	Lake and Peninsula	0.52	0.18	2.75	11.34	286	84	3	39,628
Chignik Lagoon	Lake and Peninsula	0.45	0.15	3.93	11.60	428	82	3	106,789
Chignik Lake	Lake and Peninsula	0.59	0.19	2.80		316	77	4	47,967
Chilkat Valley	Haines	0.48	0.20	3.20		292			43,855*

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Chistochina	Valdez-Cordova (CA)	0.52	0.19	2.31	11.50	292	93	2*	47,040*
Chitina	Valdez-Cordova (CA)	0.55	0.25	2.73	13.25	277	133	2*	12,763*
Chuathbaluk	Bethel (CA)	1.01	0.26	5.15	11.53	217	107	4	39,669
Circle	Yukon-Koyukuk (CA)	0.68	0.19	2.43	10.63	300	115	2*	15,060*
Coffman Cove	Prince of Wales-Hyder (CA)	0.43	0.18	2.51	13.31	306	207	3	50,619
Cold Bay	Aleutians East	0.63	0.18	3.65	13.54	405	110	2	64,504
Cordova	Valdez-Cordova (CA)	0.34	0.24	2.23	13.40	517	2,266	2	57,983
Craig	Prince of Wales-Hyder (CA)	0.21	0.16	2.30	10.36	504	1,194	3	52,410
Crooked Creek	Bethel (CA)	1.01	0.26	5.25	11.77	282	106	4	20,248
Deering	Northwest Arctic	0.78	0.35	4.71	12.64	381	126	3	38,567
Dillingham	Dillingham (CA)	0.44	0.16	3.60	15.20	475	2,245	3	59,538
Diomede	Nome (CA)	0.61	0.14	5.85	9.88	258	118	3	27,479
Dot Lake	Southeast Fairbanks (CA)	0.33	0.17	2.08		344	8	1*	38,461*
Eagle	Southeast Fairbanks (CA)	0.63	0.19	2.88	12.30	209	82	2*	25,047*
Eek	Bethel (CA)	0.69	0.20	3.83	12.03	269	283	4	20,248
Egegik	Lake and Peninsula	0.93	0.36	4.30	9.62	265	73	3	53,223
Ekwok	Dillingham (CA)	0.51	0.14	3.70		338	117	3	18,801

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Elfin Cove	Hoonah-Angoon (CA)	0.57	0.18	4.42	12.86	182	23	2	39,049
Elim	Nome (CA)	0.61	0.19	4.07	13.67	393	302	4	46,488
Emmonak	Wade Hampton (CA)	0.64	0.20	3.90	13.51	442	766	4	38,085
Fort Yukon	Yukon-Koyukuk (CA)	0.61	0.22	3.78	14.12	275	604	3	33,987
Galena	Yukon-Koyukuk (CA)	0.57	0.23	4.30	13.03	365	539	3	70,722
Gambell	Nome (CA)	0.62	0.19	3.93	13.38	370	680	4	36,397
Golovin	Nome (CA)	0.71	0.19	5.10	12.23	319	154	3	36,880
Goodnews Bay	Bethel (CA)	0.64	0.20	3.83	12.91	352	247	3	18,801
Grayling	Yukon-Koyukuk (CA)	0.71	0.21	4.17	11.83	294	182	4	25,310
Gustavus	Hoonah-Angoon (CA)	0.58	0.28	2.71	15.47	159	464	2	40,225
Haines	Haines	0.21	0.15	3.13	13.24	450	1,673	2*	44,877*
Healy Lake	Southeast Fairbanks (CA)	0.66	0.24	2.53	9.43	269	8	2*	11,2953*
Hollis	Prince of Wales-Hyder (CA)	0.21	0.16	2.80		401	118	2*	27,866*
Holy Cross	Yukon-Koyukuk (CA)	0.68	0.19	4.10	12.63	322	186	4	25,310
Hoonah	Hoonah-Angoon (CA)	0.48	0.20	2.40	14.27	424	762	3	45,156
Hooper Bay	Wade Hampton (CA)	0.62	0.19	4.00	13.53	338	1,054	4	30,854

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Hughes	Yukon-Koyukuk (CA)	0.72	0.34	4.45	12.76	291	71	3	28,202
Huslia	Yukon-Koyukuk (CA)	0.64	0.20	4.13		403	267	3	31,239
Hydaburg	Prince of Wales-Hyder (CA)	0.21	0.16	2.88	(3.84)	505	386	3	36,591
Igiugig	Lake and Peninsula	0.75	0.17	6.33	10.65	314	39	3	25,165
Kake	Petersburg (CA)	0.48	0.20	2.71	13.34	374	578	3	45,868
Kaktovik	North Slope	0.18	0.16	3.70	15.78	662	245	3	64,359
Kalskag	Bethel (CA)	0.60	0.19	3.97	13.42	396	196	4	32,782
Kaltag	Yukon-Koyukuk (CA)	0.64	0.19	4.03	14.23	338	187	3	33,747
Karluk	Kodiak Island	0.61	0.14	3.58	11.55	470	38	3	22,176
Kasigluk	Bethel (CA)	0.55	0.18	3.97	13.53	452	548	5	36,446
Kiana	Northwest Arctic	0.69	0.19	4.40	12.75	423	356	4	45,920
King Cove	Aleutians East	0.25	0.15	2.36	11.13	425	824	3	53,099
Kipnuk	Bethel (CA)	0.65	0.26	3.65	6.37	416	640	5	39,772
Kivalina	Northwest Arctic	0.71	0.20	4.40	12.78	497	370	5	35,674
Klawock	Prince of Wales-Hyder (CA)	0.21	0.16	2.85		520	723	3	40,496
Klukwan	Hoonah-Angoon (CA)	0.48	0.20	3.20		390	76	2*	27,760*
Kobuk	Northwest Arctic	0.88	0.30			422	133	4	35,578

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Kokhanok	Lake and Peninsula	0.92	0.27	4.57	12.15	337	170	3	22,658
Koliganek	Dillingham (CA)	0.51	0.14	5.06	8.36	273	185	3	51,583
Kongiganak	Bethel (CA)	0.56	0.26	4.03	12.72	452	440	5	38,471
Kotlik	Wade Hampton (CA)	0.59	0.19	3.67	13.57	455	574	5	43,677
Kotzebue	Northwest Arctic	0.48	0.18	3.94	15.16	650	3,331	3	66,138
Koyuk	Nome (CA)	0.63	0.19	4.07	13.85	471	338	4	35,193
Koyukuk	Yukon-Koyukuk (CA)	0.46	0.15	4.00		181	99	3	22,417
Kwethluk	Bethel (CA)	0.53	0.24	3.73	12.44	292	692	5	29,408
Kwigillingok	Bethel (CA)	0.51	0.17	3.90	13.23	446	330	5	41,942
Larsen Bay	Kodiak Island	0.41	0.22	3.59	11.56	301	85	3	47,244
Levelock	Lake and Peninsula	0.72	0.13	8.50		190	95	3	21,694
Lime Village	Bethel (CA)	1.27	0.67	8.20	5.62	82	24	1*	14,039*
Lower Kalskag	Bethel (CA)	0.60	0.19	3.97		299	271	4	29,648
Manley Hot Springs	Yukon-Koyukuk (CA)	1.05	0.27	2.38	10.83	122	85	4*	76,260*
Manokotak	Dillingham (CA)	0.51	0.19	3.88	12.31	334	422	4	31,095
Marshall	Wade Hampton (CA)	0.64	0.20	3.57	14.27	433	396	4	38,085
McGrath	Yukon-Koyukuk (CA)	0.61	0.17	3.82	13.19	363	327	3	49,816

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Mekoryuk	Bethel (CA)	0.66	0.19	3.70	13.08	270	177	3	35,674
Mentasta Lake	Valdez-Cordova (CA)	0.53	0.19	2.33	12.35	274	122	3*	22,335*
Minto	Yukon-Koyukuk (CA)	0.59	0.20	3.47	12.67	327	203	3*	32,227*
Mountain Village	Wade Hampton (CA)	0.61	0.20	3.93	14.63	428	806	4	36,157
Naknek	Bristol Bay	0.44	0.17	3.50	15.15	397	545	3	61,776
Napakiak	Bethel (CA)	0.98	0.25		2.69	307	345	4	33,264
Napaskiak	Bethel (CA)	0.61	0.18	3.76	8.44	448	410	5	36,800
Naukati Bay	Prince of Wales-Hyder (CA)	0.45	0.18	2.55	12.27	404	111	2	31,818
Nelson Lagoon	Aleutians East	0.66	0.27	4.32	11.98	304	58	3	50,619
New Stuyahok	Dillingham (CA)	0.63	0.19	4.13	12.79	430	510	4	30,131
Newtok	Bethel (CA)	0.81	0.40	4.68	10.25	308	351	5	37,242
Nightmute	Bethel (CA)	0.55	0.18	4.03		447	279	4	41,581
Nikolai	Yukon-Koyukuk (CA)	0.81	0.42	4.83	3.19	359	86	3	17,355
Nikolski	Aleutians West (CA)	0.61	0.22	4.50	9.72	338	23	3	44,834
Noatak	Northwest Arctic	0.81	0.19	6.70	13.86	561	490	4	35,674
Nome	Nome (CA)	0.38	0.20	3.80	15.91	458	3,610	3	68,729
Nondalton	Lake and Peninsula	0.59	0.28	4.75	11.34	394	162	3	22,658

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Noorvik	Northwest Arctic	0.70	0.20	4.47	11.74	525	619	5	60,123
Northway	Southeast Fairbanks (CA)	0.49	0.18	2.25	13.66	320	84	3*	36,109*
Nuiqsut	North Slope	0.17	0.11	3.50	11.90	640	410	4	55,578
Nulato	Yukon-Koyukuk (CA)	0.63	0.19	3.93	13.72	348	249	4	29,057
Nunam Iqua	Wade Hampton (CA)	0.54	0.25	3.85	13.15	344	183	5	33,553
Nunapitchuk	Bethel (CA)	0.55	0.18	3.97		395	483	4	33,884
Old Harbor	Kodiak Island	0.61	0.19	3.77	13.33	304	219	3	37,603
Ouzinkie	Kodiak Island	0.40	0.21	3.33	14.06	318	169	3	60,743
Pedro Bay	Lake and Peninsula	0.93	0.49	4.65	12.20	289	62	3	42,520
Pelican	Hoonah-Angoon (CA)	0.44	0.16	3.32	12.29	402	112	2	56,404
Perryville	Lake and Peninsula	0.58	0.43	3.00		300	130	3	60,020
Pilot Point	Lake and Peninsula	0.51	0.14	4.77	12.82	345	74	3	47,727
Pilot Station	Wade Hampton (CA)	0.63	0.19	3.80	12.66	423	544	5	35,950
Pitkas Point	Wade Hampton (CA)	0.62	0.18	3.50		297	92	4	48,450
Point Hope	North Slope	0.18	0.17	3.70	14.99	796	660	4	73,037
Point Lay	North Slope	0.16	0.15	3.55	13.24	683	196	4	79,545
Port Alsworth	Lake and Peninsula	0.66	0.19	4.16	11.80	335	129	3	67,975

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Port Heiden	Lake and Peninsula	0.69	0.36	4.34		283	99	3	36,880
Quinhagak	Bethel (CA)	0.65	0.20	3.90	13.78	363	680	4	29,106
Red Devil	Bethel (CA)	1.01	0.26	5.25	8.12	235	33	3	12,655
Ruby	Yukon-Koyukuk (CA)	0.92	0.58	4.01	4.60	131	162	3	28,202
Russian Mission	Wade Hampton (CA)	0.63	0.20	3.90	13.87	480	314	4	31,818
Saint Marys	Wade Hampton (CA)	0.62	0.18	3.50	14.02	349	548	4	45,557
Saint Michael	Nome (CA)	0.62	0.20	4.00	14.68	532	407	4	38,223
Saint Paul	Aleutians West (CA)	0.48	0.23	3.63	14.12	537	439	3	58,718
Sand Point	Aleutians East	0.49	0.21	3.29	13.99	457	1,051	3	64,118
Savoonga	Nome (CA)	0.59	0.20	3.93	14.20	469	660	4	27,118
Scammon Bay	Wade Hampton (CA)	0.63	0.19	3.90	13.48	439	474	5	29,648
Selawik	Northwest Arctic	0.66	0.19	4.47	13.54	475	825	4	29,648
Shageluk	Yukon-Koyukuk (CA)	0.75	0.20	4.00	11.32	252	91	4	30,854
Shaktoolik	Nome (CA)	0.61	0.19	3.93	13.81	517	245	4	36,880
Shishmaref	Nome (CA)	0.60	0.18	4.07	14.48	412	559	4	35,537
Shungnak	Northwest Arctic	0.71	0.20	4.47	13.51	533	260	5	51,343
Skagway	Skagway	0.21	0.15	1.93	14.39	467	881	3*	72,795*

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Slana	Valdez-Cordova (CA)	0.53	0.19	2.36	12.86	281	141	3*	46,106*
Sleetmute	Bethel (CA)	1.01	0.26	5.25	10.54	245	77	3	17,355
Stebbins	Nome (CA)	0.62	0.19	3.90	13.29	347	574	4	26,756
Stevens Village	Yukon-Koyukuk (CA)	1.10	0.63	5.20	10.99	102	86	3*	42,713*
Stony River	Bethel (CA)	1.01	0.26	5.30	9.64	145	47	2*	11,486*
Takotna	Yukon-Koyukuk (CA)	1.15	0.41	5.08	9.54	204	55	3	16,873
Tanana	Yukon-Koyukuk (CA)	0.74	0.26	3.38	13.42	227	242	3	34,421
Tatitlek	Valdez-Cordova (CA)	0.67	0.42	3.10	9.93	302	92	3	42,665
Teller	Nome (CA)	0.71	0.20	4.43	11.35	325	253	4	26,611
Tenakee Springs	Hoonah-Angoon (CA)	0.64	0.30	3.58	12.80	166	129	2	38,326
Tetlin	Southeast Fairbanks (CA)	0.33	0.17	2.11		334	126	4*	42,544*
Thorne Bay	Prince of Wales-Hyder (CA)	0.21	0.16	2.85	13.41	402	442	3	52,789
Togiak	Dillingham (CA)	0.61	0.18	3.90	13.16	410	808	4	27,742
Tok	Southeast Fairbanks (CA)	0.33	0.17	2.22	14.12	469	1,218	3*	55,122*
Toksook Bay	Bethel (CA)	0.55	0.18	4.03	14.45	446	601	5	34,951
Tuluksak	Bethel (CA)	0.61	0.24	4.38	13.20	244	365	5	36,519
Tuntutuliak	Bethel (CA)	0.65	0.26	3.60	13.50	357	380	4	29,504

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Tununak	Bethel (CA)	0.55	0.18	4.03		388	318	4	28,925
Twin Hills	Dillingham (CA)	0.56	0.16	5.73	7.44	328	78	3	33,987
Unalakleet	Nome (CA)	0.48	0.19	3.61	13.48	444	685	3	48,691
Unalaska	Aleutians West (CA)	0.33	0.24	2.04	13.70	483	4,092	3	80,458
Wainwright	North Slope	0.17	0.15	4.40	12.43	644	536	4	63,314
Wales	Nome (CA)	0.67	0.19	4.07	12.56	362	153	3	38,567
Whale Pass	Prince of Wales-Hyder (CA)	0.47	0.21	2.14	12.34	208	37	2*	43,714*
White Mountain	Nome (CA)	0.92	0.50	3.01	9.57	296	209	3	29,889
Yakutat	Yakutat	0.46	0.24	3.10	13.38	446	742	3	54,132